THURSDAY, JULY 30, 1914.

MAMMALIAN EVOLUTION.

A History of Land Mammals in the Western Hemisphere. By Prof. W. B. Scott. Pp. xiv + 693. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1913.) Price 21*s.* net.

THIS important work is, perhaps, the most successful attempt that has yet been made to bring within the reach of the lay reader a general account of the past history of the mammalia, a history for the reconstruction of which a vast amount of material is now available. It may be regretted that the author has found it necessary to confine his work to the mammals of the Western Hemisphere, but since the successive faunas inhabiting that region, particularly the northern half, are far better known than those of the Old World, none of the main lines along which evolution has proceeded within the group is left without adequate illustration. The much greater degree of completeness of our knowledge of the mammals of the New World is not merely due to the occurrence there of a more nearly continuous series of mammal-bearing tertiary deposits, but also to the systematic collecting that has been carried out, both in the north and south, by expeditions organised by the museums and universities. Prof. Scott has himself led such expeditions on several occasions.

The plan of the work is excellent, especially from the point of view of the general reader. The earlier chapters give a simple summary of the methods of investigation, both from a geological and palæontological point of view. A valuable chapter is added giving a brief, but clear, account of the mammalian skeleton and dentition; this with the accompanying figures should render the descriptions given in the later part of the work easily understood. A chapter on the living mammals of America is followed by a history of the succession of mammalian faunas back to the earliest Eocene, the pre-Tertiary forms being omitted. So far the volume may be regarded as an introduction to mammalian palæontology generally. In the succeeding part of the work the evolution of each group is traced in detail from its earliest appearance onwards, and it is this section which will be a revelation to those who are unacquainted with the enormous amount of material for the history of the phylum that has accumulated during the last quarter of a century. All zoologists who, from various points of view, are dealing with the question of the manner in which evolution has taken place, should read this summary of results, in which much light is thrown on such points as the occurrence of parallel and convergent evolution and on the origin of polyphyletic groups.

It is often forgotten that in palæontology we are dealing with what actually has happened, and nowhere is this better known than in the case of the mammalia. Prof. Scott himself seems to be somewhat unduly pessimistic as to the present state of palæontology, comparing it with the condition of philology in the time of Voltaire, whose famous remark: "L'étymologie est une science ou les voyelles ne font rien et les consonnes fort peu de chose," he quotes. The fact that it has been possible to write this book seems to be sufficient proof that matters are not so bad as he appears to believe.

A large number of excellent illustrations are given, many being restorations of extinct mammals, a considerable number now appearing for the first time. A useful glossary and a very complete index are appended. C. W. A.

THE PRODUCTION AND UTILISATION OF CROPS.

(1) *The Manuring of Market Garden Crops.* By Dr. Bernard Dyer and F. W. E. Shrivell. New Edition. Revised and brought up to date. Pp. 149. (London: Vinton and Co., Ltd. 1913.) Price 1*s.*

(2) *The Chemistry of Cattle Feeding and Dairying.* By J. Alan Murray. Pp. xii + 343. (London: Longmans, Green and Co., 1914.) Price 6*s.* net.

(3) *Garden Farming.* By L. C. Corbett. Pp. x + 473. (Boston and London: Ginn and Co., n.d.) Price 8*s.* 6*d.*

(1) THE first book on our list, by Dr. Dyer and Mr. Shrivell, is now well-known to all who are concerned in the raising of market garden crops. It gives the results of a series of trials at Golden Green, Hadlow, Tonbridge, which were begun in 1894 and have been systematically carried out since, so that they are now in their twentieth year.

When the experiments began little was known as to the effect of the various artificial manures on market garden crops. Many trials had been made with ordinary farm crops, but not much had been done with fruit and practically nothing with ordinary vegetables. The market gardener still used large quantities of stable manure and looked with more or less suspicion on all the purchased

artificials which were offered to him. However, the supply of stable manure tends to decrease, and twenty years have seen very considerable displacement of horse traffic by motor traffic and electric tramways so that, instead of being able to bring out large quantities of stable manure from the cities at a very low price or even for nothing, the market gardener has been compelled to buy at prices which show an uncomfortable tendency to rise. Indeed, the authors go so far as to predict that at no distant time town stable manure will be for many of its long-accustomed users an unattainable luxury.

The authors, therefore, laid out a series of experiments to see what would be the effect of artificial manures on market garden crops, and whether the same sort of results would be obtained as on ordinary agricultural crops. The results were as might have been expected; the artificials exerted their full effect and gave crops as large as those obtained in the ordinary way, sometimes even larger. A certain foundation of organic manure is necessary in order to give satisfactory tilth to the soil and to increase its water-holding capacity. But this does not necessitate the large quantities which had formerly been used, and the authors make some useful suggestions as to the way in which stable manure may be supplemented by artificials so that considerably increased crops may be obtained.

(2) Mr. Alan Murray is well known as a careful and painstaking teacher who takes a good deal of trouble over the preparation of his lectures and of his books.

In the volume before us he gives a very interesting account of the chemistry of cattle feeding and dairying drawn up for the students at agricultural colleges and elsewhere. It is divided into four parts. The first deals with the chemistry of plants and animal constituents and includes chapters on the carbohydrates, the fats, proteins, etc.; the second deals with the physiology of nutrition and milk production; the third with the properties of feeding stuffs, and the fourth with dairying. It is obviously a good deal to expect of one man that he should cover so wide a range of subjects, and we hope the time is not far distant when teachers of agricultural chemistry will not be under the necessity of giving preliminary courses of advanced organic chemistry and elementary physiology.

We think, perhaps, Mr. Murray would have done wisely to have made more use of the series of bio-chemical monographs edited by Plimmer and Hopkins, instead of the less recent books that he quotes. Probably some such method would be a simple way out of the difficulty at the colleges at present; undoubtedly the students do need these preliminary courses in organic chemistry and physiology, but it is unreasonable that the agricultural chemist should be required to give them.

Passing on to the more strictly technical side, the descriptions of the feeding stuffs and methods of compounding rations are very well done, and a graphic method is given for working out some of the practical problems which will greatly facilitate the work of teacher and student. There is also an interesting chart showing the composition of the foods. Altogether the book is one that cannot fail to be useful.

(3) This book is frankly technical and written for the American grower. It, therefore, naturally appeals much less to the English reader than to those in the States. The general reader, however, will find an interesting account of the cultivation of certain crops. Beans play a large part in American dietaries, and large areas are given up to their cultivation in certain sections of the States, particularly in New York and Michigan. Indeed, in some parts beans have become as much a staple crop as wheat was a quarter of a century ago, and have largely displaced it.

The growth of sweet corn is also dealt with at length, the methods of cultivation, of harvesting, and the varieties being fully described. At present 80 per cent. of the seed corn is grown in Nebraska, but large amounts are raised in the other States for the canning industry, the requirements of which are enormous.

The ordinary potato is described as the Irish potato in contradistinction to a wholly different crop, the sweet potato (*Ipomoea batatas*); it received this name from the fact that it is one of the standard foods of the Irish people. "Because of its enormous yields," the author states, "and its easy cultivation, it has grown to be an important economic factor in the maintenance of the dense population of that country." Potatoes as a farm crop bulk largely in the north-eastern section of the States, where the method of growth is not unlike ours and the same sort of troubles seem to arise. There is one pest, however, from which we have fortunately been free: the Colorado potato beetle, described as being the most serious insect enemy of the potato.

Each crop is carefully described, and there are maps showing their distribution in the States. Altogether, it is a book that the American grower is not likely to be able to dispense with, and so far as one can judge, the information seems to be very sound; it is certainly well put together and illustrated with plenty of good photographs.

E. J. R.

ROBERTS-AUSTEN.

Roberts-Austen: a Record of his Work. Being a Selection of the Addresses and Metallurgical Papers, together with an Account of the Researches of Sir William Chandler Roberts-Austen. Compiled and edited by S. W. Smith. Pp. xii+382. (London: C. Griffin and Co., Ltd., 1914.) Price 21*s.* net.

IT is pleasant to see that one of Roberts-Austen's former assistants has been willing to devote himself to the preparation of this record of the work of the most distinguished metallurgical chemist of his day. It is pleasant, too, to find that the handsome volume which is the result of Mr. Smith's labour of love is a memorial in every way worthy of his old professor's fame. In well-chosen, felicitous language, Mr. Smith traces Sir William's career from his student days at the Royal School of Mines to his death at the age of fifty-nine, when he was still actively engaged in many directions. For the most part, however, the biographer leaves him to speak for himself.

A large part of the book is taken up with a reprint of lectures and addresses delivered to his students, to the British Association, to the Society of Arts at the Royal Institution, and as president of the Iron and Steel Institute. These addresses are the best expression of Roberts-Austen's personality. They reveal how very much "worth while" he found metallurgy to be. They show the enthusiasm with which he sought to open out ways for the escape of what he felt to be "imprisoned splendour." The papers giving the results of Roberts-Austen's own experimental researches have been usefully summarised by Mr. Smith, who has made their spirit live without encumbering his pages with details. No work has been entirely omitted. The record is complete.

Roberts-Austen's life was largely given to the Mint. As the assayer for more than thirty years, he was responsible for the accuracy of the composition of more than 150,000,000*l.* of gold and 31,000,000*l.* of silver coins. In his hands the scientific reputation of the Mint was maintained at a high level. He was also for many of these years the professor of metallurgy at the Royal School of Mines. His numerous researches on the properties of metals and alloys were so important as to obtain immediate recognition from the scientific world. His work on government committees was almost unceasing. If, however, an opinion may be expressed by one of his admirers, it is that he will be best remembered for the impetus which he gave to the scientific study of metals at a time when it was beginning to be understood that empiricism must give place to system even in metallurgy. If the metallurgical industries are paying more and more attention to the need of applying scientific principles in their practice, the movement is largely due to Roberts-Austen's initiative and enthusiasm.

T. K. ROSE.

NEW BOOKS ON CHEMISTRY.

(1) *Outlines of Theoretical Chemistry.* By Prof. F. H. Getman. Pp. xi+467. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1913.) Price 15*s.* net.

(2) *A New Era in Chemistry.* By H. C. Jones. Pp. xii+326. (London: Constable and Co., Ltd., 1913.) Price 8*s.* 6*d.* net.

(3) *The Progress of Scientific Chemistry in our own Times, with Biographical Notices.* By Sir William A. Tilden. Second edition. Pp. xii+366. (London: Longmans, Green and Co., 1913.) Price 7*s.* 6*d.* net.

(1) AS an introduction to the study of physical chemistry Prof. Getman's "Outlines" may be warmly recommended. It follows the usual order and arrangement of such subjects, dealing mainly with the physical properties of substances. It is carefully and clearly written, and most of the subjects are treated in a sufficiently simple fashion to enable a student who has completed an elementary course on chemistry to understand them without difficulty. The only question which has arisen in reading the book is whether the very brief and necessarily superficial accounts which are given of some of the topics are worth the space devoted to them. It is not merely that the account is incomplete; it has no beginning, and leads nowhere. It conveys as much information as a worn strip of ground to the lost traveller who is doubtful whether it is a pathway or not. We refer more particularly to the discussion of the properties of liquids, such as molecular volume, refraction, magnetic rotation, and so forth. The reply might, of course, be made that it is better for a student to know of the existence of such properties, even if they tell him little or nothing, than to remain entirely ignorant of them; but in a small book like this (which, by the way, seems very expensive for its size) we are of opinion that the space might be better utilised. One excellent feature of the volume is the set of problems introduced at the end of each chapter.

(2) The title of Mr. H. C. Jones's book, "A New Era in Chemistry," seemed to promise attractive reading; but we must confess that the promise has not been fulfilled. The book, which covers a period from 1887 to the present time, is partly historical, partly explanatory, and partly philosophical. The year 1887 is selected as mark-

ing the advent of a new era in consequence of the appearance of the first volume of the *Zeitschrift für physikalische Chemie*. This year affords, no doubt, an excellent point of departure; but to qualify it as "the beginning of the transition from a system into a science of chemistry" (p. 17) is surely incorrect. Granted the profound development which has taken place in the direction of physical chemistry during this period, it would be a gross misconception of the word "science" to deny the term to chemistry during the greater part of last century. If, as the author truly remarks, it is the generalisations or laws which transform chemistry from a system into a science, he assuredly contradicts his assertion when, for example, he develops the laws connected with the history of mass action. But, apart from this, there are many other statements which are equally inaccurate. One would scarcely venture to describe Stas's method as "crude" (p. 3), or to regard Prouts's hypothesis as correlating atomic weights with the physical and chemical properties of the elements (p. 4), or to represent Kekulé's benzene formula as a triangle with the carbon and hydrogen groups occupying the corners and middle points of the sides (p. 12), or to state that Le Bel's advance on Pasteur's theory consisted in showing "that optical activity is the expression of asymmetry, but that this asymmetry is of the chemical molecule"; for it was precisely what Pasteur did suggest, as anyone who has read his lectures on molecular asymmetry can scarcely fail to remember.

Sufficient has been stated to show a certain amount of carelessness in the handling of historical details; and, in regard to the elucidation of complex problems, we doubt whether any student who was not already familiar with the subject would follow the account of, for example, Berthollet's contribution to the law of mass action, or Le Chatelier's rule (p. 80), or the explanation of osmotic pressure (p. 90). The expressions "to arrest attention to the importance of," "the method was to cut and try to see what result was obtained," are not exactly elegant English, and the frequent repetition of the same word, such as "generalisation," which occurs twenty times in seven pages, point to hurried and slovenly compilation. The book is, on the whole, disappointing.

(3) The first edition of Sir William Tilden's book on the progress of scientific chemistry is too well known and appreciated for any special recommendation of the new edition, which merely brings the subject up-to-date, to be necessary. For those who may not have seen or read the earlier volume, it may be stated that it sets forth the main facts and theories of chemistry in historical sequence, and traces the development of the various branches of the science down to the present time. The subjects are not discussed with any great detail or elaboration, but the style is fresh and attractive, and the explanations clear and incisive, so that the merest tyro in chemistry can easily follow all that he reads. With one notable exception it would be difficult to find anyone at the present day whose long association with chemistry both as teacher and investigator, and whose personal contact with many of the great chemists of this and the latter part of last century, could better fit him for the task of a historian, and the volume will furnish not the least valuable of the many contributions to chemistry of its distinguished author.

J. B. C.

OUR BOOKSHELF.

The Makers of Modern Agriculture. By Dr. W. Macdonald. Pp. 82. (London: Macmillan and Co., Ltd., 1914.) Price 2*s.* 6*d.* net.

In this little book Dr. Macdonald has given a very pleasant and readable account of five of the makers of modern agriculture, viz., Jethro Tull, Coke of Norfolk, Arthur Young, John Sinclair, and Cyrus H. McCormick. He has carefully examined the best biographies available, and has given a summary of the lives and works of his subjects, which cannot fail to be of wide interest to all concerned in the development of agricultural science. If we have a fault to find, it is that the title is too comprehensive: Lawes and Gilbert are not mentioned, yet they must surely stand among the makers of modern agriculture, for it was they who worked out the application of artificial manures to agricultural practice. Three of the five are Englishmen, one is Scotch, and one American. Tull and Coke are in some ways the most interesting of the five.

Tull was born at Basildon in Berkshire in 1674, and did his best work in the same county. His claim to fame is that he invented the method of drilling seed, which has now displaced the older method of broadcasting or dibbling. He was thus able to secure an opportunity for cultivating land even while the crop was growing. In consequence, bare fallow could be dispensed with, and the land could be utilised throughout the whole of the rotation. The principles that he laid down are wonderfully accurate, while his methods have changed only in detail and not in essentials.

Coke of Norfolk is well known for his remarkable work in the development of light, sandy soils. It is unfortunate that no satisfactory account of his agricultural experiments has yet been published, and one can only hope that this oversight on the part of agricultural writers will soon be remedied. His experiments at any rate were well known in his own day, and the practices he introduced have been widely followed ever since.

The Horticultural Notebook. Compiled by J. C. Newsham. Third edition, thoroughly revised. Pp. xx+418. (London: Crosby Lockwood and Son, 1914.) Price 4*s.* 6*d.* net.

THE fact that this work of reference has reached its third edition, and that its price has been reduced, proves that its usefulness is now generally recognised. It is, indeed, a book of convenient size and shape, which anyone whose interests are largely bound up in horticulture will find useful to have on his writing-table. As everyone knows who follows this pursuit, minor problems are cropping up almost every day of one's life. The strength of an insecticide or a manure, some simple way of ascertaining the height of a tree without climbing it, the right dimensions of a lawn tennis court, how to make a grafting wax: these are samples of the kind of question for which those concerned with gardens are constantly needing an answer. This the "Horticultural Note-Book" sets out to supply, and we do not find that it often fails.

Although the serious student will need something more detailed than is here furnished, the book is not devoid of scientific teaching. A synopsis of the natural orders of plants, for instance, is concisely and conveniently arranged and helpful in "running down" a plant. It is not, however, in this direction (which suggests too much a shilling encyclopedia) that the value of the book consists, so much as in the collection of garden recipes and rules, and in much tabulated information. The ancient and remarkably persistent error that the plane tree of the streets is the American *Platanus occidentalis* is once more repeated here (p. 368), although it has several times been pointed out in these columns that the tree is really the Old World *P. acerifolia*.

Ornamental Lathework for Amateurs. By C. H. C. Pp. 121+xii plates. (London: Percival Marshall and Co., n.d.) Price 3*s.* 6*d.* net.

PLAIN turning is carried out in an ordinary lathe by revolving the work and operating on it by tools held in the hand or in a slide-rest. In ornamental turning, an object already subjected to plain turning processes is ornamented by further operations carried out on it by cutters which are made to revolve independently of the lathe mandrel. Ornamental turning is an exceedingly beautiful art, and the object of the little book before us is to awaken the interest of those who have adopted turning as a hobby, and to show how simply an ordinary turning lathe may be modified so as to be capable of producing beautiful examples of ornamental turning. While many examples are given and illustrated by photographs, it is not the author's intention that these should be used as designs to be worked out, but rather to stimulate the worker to devise new designs and methods for himself. Drawings of many useful types of tools are given, mostly of a simple character. The book can be recommended as a useful introduction to any amateur turner who has not yet taken up this fascinating branch of his art.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Rayleigh's Law of Extinction and the Quantum Hypothesis.

THE bearing of Rayleigh's law of gaseous extinction on some of the fundamental aspects of radiation theory does not seem to have been sufficiently emphasised in recent reports and publications on modern molecular physics. The coefficient of attenuation κ of radiation of wave-length λ travelling through a gas containing n_0 molecules per unit volume was given by Rayleigh [1] so long ago as 1871 in the form $\kappa = \frac{8}{3}\pi^3(\mu^2_0-1)^2\lambda^{-4}/n_0$, μ_0 being the refractive index of the gas. It is of importance to notice that the law in question is one of the most fundamental results of molecular dynamics, its final expression being an invariant with respect to the theories of the æther or of the molecule employed,[2] while in its derivation there is no need to draw on resources outside classical dynamics and continuous energy-flow. From the point of view of elementary electromagnetic theory, the above expression for κ is very easily derived along lines suggested in a problem set in part ii. of the "Mathematical Tripos" [3]; use is made of the conventional electrical doublet set into forced vibrations by a train of electromagnetic waves; by making use of the radiation formula for accelerated charges and Poynting's theorem, the flow of energy from the doublet is easily calculated in terms of the amplitude of vibration; the oscillations of the doublet contribute a term to Maxwell's displacement current, enabling the amplitude to be expressed in terms of the refractive index of the gas; by considering the depletion of energy from the original beam as a result of this scattering, and eliminating the amplitude, the above expression for κ is easily obtained. In a recent paper, Natanson [4] has subjected the derivation of Rayleigh's law to minute criticism on the grounds of the classical electromagnetic theory, allowing for a damping term arising from the mechanical reaction due to radiation, and taking into special consideration the summation of the aggregate radiation from the random distribution of doublets which are supposed to constitute the molecules of the gas; the final result is a vindication of the above expression for the coefficient of attenuation to a very high order of accuracy. It may be noticed in passing that the same electromagnetic system forms the basis of Planck's [5] theory of "black-body" radiation, the interpretation of experiment in this case, however, necessitating the hypothesis of discontinuous energy-flow, or the emission of energy by "quanta."

For an adequate experimental verification of Rayleigh's law recourse must be had to observations on the extinction of solar radiation of different wave-lengths by the earth's atmosphere. The importance of the observations of the Smithsonian Astrophysical Observatory on atmospheric transmission recently carried out by Abbot and Fowle [6] in connection with their determinations of the solar constant at Mount Wilson, in furnishing material for a study of mole-

[1] Rayleigh, *Phil. Mag.*, xli., pp. 107, 274, 447 (1871); "Collected Works," i., pp. 87, 104, 518.
[2] Schuster, "Theory of Optics," 2nd ed. (1909), p. 325.
[3] Mathematical Tripos, Part ii., June 2, 1906.
[4] Natanson, *Bull. Inter. de l'Académie des Sciences de Cracovie* January 5, 1914.
[5] Planck, "Theory of Heat Radiation" (Trans. by Masius, Blakiston's, Philadelphia, 1914), part iv., chap. iii. p. 165.
[6] Annals of the Smithsonian Astrophysical Observatory. Washington: vol. ii. (1908); vol. iii. (1913).

cular scattering was first pointed out by Schuster[7]; the question was examined in further detail by Natanson[8] and independently by the writer.[9]

If S refer to the intensity of wave-length λ outside the earth's atmosphere, and $E(x)$ to the intensity normal to the sun's rays reaching a level x above the sea from a zenith distance ζ, we have $E(x)=Se^{-Cx \sec. \zeta}$, where C_x is the coefficient of attenuation at the station in question. If allowance be made for the conversion of radiant energy into heat, it is shown by the writer that C_x may be expressed in the form $C_x=\gamma+\beta\lambda^{-4}$; β is proportional to the pressure of the atmosphere, so that if β_0 refer to standard conditions of pressure and temperature we have $\beta_0=\beta p_0/p$, where p is the barometric pressure at the station at the time of observation. Finally, in terms of the refractive index of air under standard conditions, it is shown that $\beta_0=\frac{8}{3}\pi^3(\mu^2_0-1)^2H_0/n_0$, where H_0 is the height of the "homogeneous atmosphere" calculated at 0° C., and n_0 the number of molecules of air per cm.^{3} under standard conditions. It may be remarked that these relations may be obtained in a very general manner independently of any assumptions regarding the atmospheric gradients of temperature and pressure, provided that the planes of equal density be parallel to the earth's surface.

The accuracy of the experimental measure of the zenith transmission, $a=e^{-Cx}$, rests ultimately on the ratio of two galvanometer deflections, or the measurements of two ordinates of a bolograph record, quantities measurable to well within 1 per cent. Owing to the occurrence of the *ratio* only, corrections due to the imperfect reflecting powers of mirrors, absorption by prisms, slight reflection from the bolometer-strip, etc., do not appear. The determination of the remaining observed quantities, zenith distances of the sun, wave-lengths, and barometric pressures are all measurable to a high degree of accuracy, so that it does not seem too much to say that the zenith transmission can be determined over a considerable range of wave-lengths to an accuracy well within 1 per cent.

Data on atmospheric extinction recently made available by the publication of vol iii. of the Annals of the Smithsonian Astrophysical Observatory are given in terms of the zenith transmission a, for the most part over a range of ten wave-lengths, avoiding regions of selective transmission. The average zenith transmission, $\bar{a}$, is determined for a large number of days each year; unfortunately it is not quite exact to derive the mean coefficient of attentuation as $\log_e \bar{a}$; the error committed is difficult to estimate beforehand, but will be negligible only when the attentuation coefficients are small or when they deviate very little from their mean value; actual trial shows that the error committed may amount to as much as 2 or 3 per cent. In addition, there is the probability that the constants β and γ are independent variables; for these reasons it seemed advisable to the writer to determine β and γ independently from each day's observations from the constants of the line of closest fit (calculated by least squares) corresponding to the formula $C_x=\gamma+\beta\lambda^{-4}$, taking as variables C_x and λ^{-4} measured in units chosen according to a suitable scale. The computations were very ably carried out by Mr. A. A. Scott and Mr. Etienne S. Bieler, both of McGill University, working under a grant from the Rumford Fund of the National Academy of Sciences. The daily determinations of β and γ have now been extended to all the transmission observations as yet published by the Smithsonian Astrophysical Observatory. Comparison with theory is most conveniently made by calculating n_0 according to the preceding formulæ. For each selection of wave-lengths a value of $(\mu^2_0-1)^2$ weighted according to λ^{-4} was employed, while the barometric pressures at the times of observation were obtained through the courtesy of Dr. Abbot.

Pending full publication and a more detailed discussion of the results obtained, a summary of the mean values of β and γ, together with the corresponding determinations of n_0, and the probable deviation from the mean is given in the following table:—

Constants of Atmospheric Absorption.

Annals, vol.	Table	No.	Days	Mean γ	Mean β	Mean n_0	Wave-lengths
Mount Whitney, California. Elevation, 4420 Metres. Average Barometer, 446·7 mm.							
iii.	46	4	(1909–10)	0·014±0·003	0·0049 ±0·0001	$(2·84±0·06)\times10^{19}$	10 wave-lengths, 0·327μ to 0·574μ
Bassour, Algeria. Elevation, 1160 Metres. Mean Barometer, 664·6 mm.							
iii.	46	9	(1911–12)	0·080±0·012	0·00723±0·0002	$(2·85±0·07)\times10^{19}$	10 wave-lengths,
iii.	46	2	(1912)	0·27 ±0·01	0·00696±0·0001	$(2·96±0·03)$	0·340μ to 0·532μ
Mount Wilson, California. Elevation, 1780 Metres. Mean Barometer, 623·5 mm.							
ii.	14	59	(1905)	0·052±0·002	0·00673±0·0001	$(2·82±0·04)\times10^{19}$	4 wave-lengths,
ii.	14	62	(1906)	0·058±0·002	0·00613±0·00006	(3·10±0·03)	0·40μ 0·45μ 0·50μ
iii.	33	114	(1908)	0·076±0·002	0·00691±0·00006	(2·75±0·02)	and 0·60μ
iii.	34	96	(1909)	0·031±0·001	0·00687±0·00008	(2·80±0·03)	9 wave-lengths,
iii.	35	115	(1910)	0·023±0·001	0·00696±0·00008	(2·76±0·02)	0·35μ 0·40μ 0·45μ
iii.	36	113	(1911)	0·022±0·001	0·00696±0·00005	(2·76±0·02)	0·50μ 0·70μ 0·80μ 1·00μ 1·20μ 1·60μ

The marked increase of γ in the second series at Bassour is due to the presence of volcanic haze from the Mount Katmai eruption, June 6–7, 1912.

The mean value of n_0 obtained by combining the results of Tables 34, 35, and 36 (324 days, 1909–11) gives $n_0=(\mathbf{2·78}_1\pm\mathbf{0·01}_3)\times\mathbf{10}^{\mathbf{19}}$. Hence we obtain for Avogadro's number the value $N=(\mathbf{6·23\pm0·03})\times\mathbf{10}^{\mathbf{23}}$, and for the charge on the electron $e=(\mathbf{4·64\pm0·02})\times\mathbf{10}^{-\mathbf{10}}$ e.s. units.

The above determination of n_0 compares favourably with Rutherford's[10] 2·78, Planck's[11] 2·77, and Millikan's[12] (2·705±0·005), while the value recently obtained by Fowle[13] from a somewhat different treatment of the Mount Wilson data gave 2·56.

[7] Schuster, NATURE, July 22, 1909: "Optics," 2nd ed., 1909, p. 329.
[8] Natanson, *Bull. Inter. de l'Académie des Sciences de Cracovie*, December 13, 1909.
[9] King, Phil. Trans. Roy. Soc., 212 A, p. 392, 1912.
[10] E. Rutherford and H. Geiger, Roy. Soc. Proc., A, vol. lxxxi., 190 p. 171.
[11] Planck, *loc. cit.*, p. 172.
[12] Millikan, *Phys. Rev.*, ii., ser. 2, pp. 109–143, August, 1913: *Phys. Zeitschrift*, xiv., pp. 796–812, September 1, 1913.
[13] Fowle, *Astrophysical Journal*, xxxviii., No. 4, p. 398, November, 1913.

Although the above reductions of a series of self-contained observations on atmospheric extinction yield a determination of n_0 to an order of accuracy not very much less than that of the best existing determinations, their chief interest lies in the fact that they constitute as rigorous an experimental test of Rayleigh's law as may be expected in view of the practical impossibility of securing absolutely perfect atmospheric conditions. From the value of γ may be calculated the fraction of radiant energy converted per cm. of path into thermal molecular agitation; taking a value of $\gamma_0 = 0{\cdot}032$ for air under standard conditions, it is easily shown that in a stream of radiation corresponding to the solar constant the rate of increase of temperature amounts to 0·015° C. an hour.[14] As the above value of γ, even for the comparatively dust-free air above Mount Wilson, includes to a certain extent the effect of volcanic haze, it follows that in a pure gas partition of energy cannot take place at a rate greater than is represented by the above-mentioned rate of increase of temperature. We have in this case an excellent illustration of two interpenetrating dynamical systems (the æthereal system of electromagnetic waves and the molecular gaseous system) allowing of partition of energy, it at all, at an excessively slow rate compared with the rate of equalisation of energy distributions which is capable of being realised in each system considered separately. It is interesting to notice also that this rate is enormously increased by the presence of constrained molecular systems (matter in the solid or liquid state, such as dust-particles, water droplets, etc.).

Further, the experimental verification of Rayleigh's law to a high degree of accuracy is interesting in that its final expression is a result of classical dynamics and continuous absorption and re-emission of energy; from this point of view it seems to the writer that the hypothesis of emission by "quanta" cannot be universally applied to radiating molecular systems.

In this connection it is interesting to notice that in the recent theory of specific heats as proposed by Debye,[15] Born and Kàrmàn,[16] and now generally recognised as an adequate interpretation of experimental results, the interpretation of Planck's constant h has been transferred from association with the individual atom to the process whereby energy is interchanged between molecular systems vibrating under those intramolecular forces and constraints which in their integrated form determine the elastic properties of the solid state. Similarly in view of the above-mentioned verification of Rayleigh's law it is difficult to see how Planck's "quantum" can be associated with the individual molecule, at any rate for that system of vibrations which enter into the forced oscillations with consequent re-emission of radiant energy thus constituting the phenomenon of molecular scattering. In the opinion of the writer one might with advantage seek for the interpretation of Planck's h in the problem of "black-body" radiation in the fact that the radiating units probably perform vibrations under the intramolecular forces and constraints which determine the solid state, while at the same time the reaction of the total aggregate of radiating systems must profoundly modify the character of the radiation from the original sources before it emerges from the interior of the solid into free space for experimental examination.

LOUIS V. KING.

McGill University, June 6, 1914.

[14] King, *loc. cit.*, p. 304.
[15] Debye, *Ann. der Phys.*, iv., 39, p. 789. (1912.)
[16] Born and Kàrmàn, *Phys. Zeitschr.*, xiv., p. 15; also p. 65. (1913.)

The Destruction of Wild Peafowl in India.

MAY I direct attention to the subjoined extract from the *Englishman* of Calcutta of June 4 last? It will give some idea of the degree to which wild peafowl are being destroyed in India so long as the open market for foreign plumage exists in the maritime countries of Europe. Of course, there is no objection whatever to the use of peacocks' feathers in any form of art, but sufficient for the purpose should be obtained from the millions of domesticated peafowl in Europe, Asia, America, and North Africa, without pursuing a war of extermination against the wild species still remaining in India. The peacock sheds his wondrously beautiful tail feathers every summer or early autumn, but I have reason to think that the bulk of the peacocks' plumes exported from India are derived from wild birds shot for the purpose. Mr. C. William Beebe, of the New York Zoological Society, has already directed attention to the extent to which the peafowl of India and Burma are being eliminated from the woodland. One would only ask in this case control of the destruction within reasonable limits.

H. H. JOHNSTON.

"On Tuesday, the Calcutta Customs authorities seized forty-four large cases containing peacock feathers on one of the steamers. These cases were to be delivered at Hamburg. By a mere chance, they escaped detection when first presented before shipment at the Customs office, but when they had been placed on board the steamer, information reached the Customs authorities as to their contents. Promptly, Customs officers were sent to bring back the cases to the office, where on examination they were found to contain peacock feathers.

"The feathers will of course be confiscated and the exporter, whose name was not disclosed, will, if found, be fined heavily. This consignment of feathers, in a way, constitutes a record. A feather which costs half an anna in India brings in a very considerable sum in Germany.

"It is stated that cases of smuggling feathers are now again becoming very common, and the Customs officers are almost daily making seizures of the contraband article. In spite, however, of their vigilance in some cases, the smugglers succeed in sending away feathers. The smugglers employ ingenious methods; in many instances they send the feathers under assumed names; then the consignee's name is also very difficult to ascertain and in some cases, where valuable feathers are concerned, the smugglers send them by post in letters or as registered parcels.

"There is at the present moment a large demand for peacock feathers in Europe, and the majority of the consignments detected in Calcutta contained feathers."—The *Englishman*, June 4, 1914.

THE AUSTRALIAN MEETING OF THE BRITISH ASSOCIATION.

MORE than three hundred members of the British Association (including some forty foreign and colonial members) are on their way to Australia to attend the eighty-fourth annual meeting, which begins in Adelaide on August 8. The Australian organisation has found it possible to offer hospitality to the whole party without distinction, and the State Governments are providing all the visitors with passes over their respective railway lines during the time of the official meeting. A number of leading members have already been for some time in the country for purposes of

research, and others will remain for some weeks or months after the proceedings terminate in Brisbane on September 1. In the desire that the visitors should spend their few week-ends in acquainting themselves with extra-metropolitan activities and possibilities, a heavy programme of tours has been arranged, and upon these all members from overseas will be the guests either of the particular central State organisation concerned or of a committee in the locality visited. It is unfortunate from many points of view that it has been necessary to hold the meeting in one of the Australian winter months, for much of the pleasure of the excursions will depend upon the chances of the weather.

The Western Australian advance party of seventy began work in Perth on July 28. In a previous article a summary was given of the places to be visited by the various divisions of the party. Public lectures will be delivered by Profs. W. A. Herdman (Liverpool) and A. S. Eddington (Cambridge), Dr. A. D. Waller (London), Mr. Henry Balfour (Oxford), and Mr. C. A. Buckmaster (London).

On August 8 the whole party from overseas will assemble in Adelaide. Twenty mineralogists and chemists will leave at once for Port Pirie and Broken Hill, the most famous smelting and mining centres in Australia. As guests of the manager of the Broken Hill Proprietary Company and of the Broken Hill Mining Managers' Association they will spend four very strenuous days before rejoining their colleagues in Adelaide. At the first evening discourse to be delivered by the retiring president, Sir Oliver Lodge, the chair will be taken by the Governor of South Australia (vice-president), who will officially welcome the Association to the State. Sir Oliver Lodge has taken as his subject "The Æther of Space." The second discourse will be by Prof. W. J. Sollas (Oxford), while Prof. E. C. K. Gonner (Liverpool) will deliver a Citizens' Lecture. Sectional presidential addresses will be given in geography and agriculture. The social engagements of the stay in Adelaide include a reception by the Governor and a ball by the mayor.

The sectional work proper begins in Melbourne, where the party will arrive in three special trains on August 13. Presidential addresses will be delivered in the sections of physics and mathematics, chemistry, zoology, economics, and physiology. Both here and in Sydney the sectional sessions will be devoted largely to discussions upon broad problems. Among the subjects to be brought forward are the structure of atoms and molecules, metabolism, the nature and origin of species, wireless telegraphy, the physiography of arid lands, some antarctic problems, mimicry in Australian insects, town planning, is Australian culture simple or complex?, the study of native culture in relation to administration, climate from the physiological point of view, anæsthetics, the origin of the angiosperms, the literary side of education, vocational education, irrigation and dry farming. Town planning will be a leading feature of the work of the economics section, and the plans for the new federal capital have been lent to the section by the Commonwealth Government. To those economists whose interests lie in current practical politics, the fact that Australia will, throughout the meeting, be preparing for a General Election early in September may offer some attraction.

Melbourne being the temporary seat of Government, its social functions include a reception by the Governor-General and the Federal Ministry, to be held on the first night of the meeting. In addition, the State Governor and Government and the Lord Mayor will entertain the Association. Prof. Bateson will deliver the first part of his presidential address, and discourses will be given by Prof. E. B. Poulton (Oxford) and the Astronomer Royal, and Citizens' Lectures by Prof. H. B. Dixon (Manchester) and Dr. W. Rosenhain (National Physical Laboratory).

The long journey of 600 miles to Sydney will be made during the night of August 19, and on the evening of the following day will be delivered the second part of the presidential address. The public lecturers in Sydney are Sir Ernest Rutherford, Prof. Elliot Smith (Manchester), Prof. Benjamin Moore (Liverpool), and Prof. H. H. Turner (Oxford). In the sections, besides discussions and papers there will be presidential addresses in geology, engineering, anthropology, botany, and education. The lighter side of the programme includes a luncheon by the State Government and entertainments by the State Governor and the Senate of the University, and a ball by the Lord Mayor.

After the Sydney session the overseas party divides. Some seventy proceed to New Zealand, while some 200 travel further north on a twenty-eight hours' journey to Brisbane. Here Mr. A. D. Hall (agriculture) and Prof. E. W. Brown, of Yale (cosmical physics), will address their sections, and public lectures will be given by Profs. H. E. Armstrong and G. W. O. Howe (London), Dr. A. C. Haddon (Cambridge), and at the last meeting, Sir Edward Schäfer. Social entertainments have also been arranged. It is likely that in most of the capital cities the universities will confer degrees *honoris causa* upon a few of the leading members of the visiting party.

It is not possible adequately and briefly to summarise the excursions programme. The organisation has endeavoured to include those localities most suitable from the point of view of the professional interests of the guests, at the same time not failing to include some places of chiefly scenic attraction. The limits imposed by the necessity for easy accessibility and by the exceedingly short time at disposal in any one State, have made the task very difficult. A wide and probably rather embarrassing choice will be open to the visitor, but except for those members who can remain in Australia after the meeting it will seldom be possible to journey very far from the coastline. The names of most of the places to which excursions have been planned have already been mentioned in a previous article.

Literature in abundance has been prepared for

the use of members. The Federal Handbook gives general accounts of the scientifically important aspects of the country, and it was some time ago placed in the hands of prospective visitors. It is the intention of the Commonwealth Government also to present a copy to each member of the general committee and to each foreign corresponding member. An admirable supplement to this work is given by the handbooks issued by the respective States, and by booklets which deal specifically with the localities chosen as objects of excursions.

It is a misfortune that so great a proportion of the time which members can spare from their work in Great Britain must be spent on the ocean; but it may be conceded that the proposed arrangements in Australia, if successfully carried through, will have offered to the visiting party as full and well-chosen an opportunity for achieving the objects of a colonial meeting of the British Association as it is possible to obtain in the short space of three and a half weeks, devoted to visiting four cities distributed along a stretch of railway line 1800 miles in length.

THE ELECTRIC EMISSIVITY AND THE DIRECTIVE DISINTEGRATION OF HOT BODIES.

THAT department of physics which concerns itself with the electrical and kindred properties of incandescent bodies has recently attracted a good deal of controversial attention. From the outset, the subject aroused great interest, possibly in view of its speculative possibilities for solar physicists and others, and numerous workers have carried its development into great detail and some complexity. In a short *résumé* of the two phenomena specifically mentioned in the title of this article, we can do no more than touch on general outlines. Of the several aspects, the electrical one, now generally known as "thermionics," calls for first mention.

Electric Emissivity.—It was Guthrie in 1873, at the Royal School of Mines, who did pioneer work on what we now know to be a characteristic feature of incandescent bodies, and that is, to put it simply, their property of emitting an excess of positive electricity at a red heat, and at higher temperatures, a much larger excess of negative. The positive electrification, we have reason to believe, is carried chiefly by atoms or molecules of either occluded gas (such as CO), or impurities such as the alkali metals.

The degree of the negative emissivity at high temperatures was shown by subsequent workers, Elster and Geitel among others, to depend not only on the body and its temperature, but also on the nature and pressure of the surrounding gas. Sir J. J. Thomson established the fact that no matter what the nature of the hot body, the electron was the prime agent in the transport of the negative electricity; and later, Prof. O. W. Richardson (then a student at the Cavendish Laboratory), in his early work on a subject now associated with his name, concluded that these thermionic currents were due to a kind of "electric evaporation" of the unattached electrons in the solid.

Treating the problem from this point of view, Richardson derived his well-known expression:—

$$I = a\theta^{\frac{1}{2}}e^{-b/\theta},$$

where I is the saturation current, θ the absolute temperature, and a and b are constants for any particular material. As will be seen, the formula (which is identical in type with that of Kirchoff for vapour-pressure, and shares its peculiar "elasticity") contemplates the electric emission as due solely to the effect of temperature.

It was not until 1912 that doubts were first cast on the adequacy of this explanation. Pring and Parker (*Phil. Mag.*, January, 1912), working in Sir Ernest Rutherford's laboratory at Manchester, took especial pains to purify and free from gas a sample of carbon rod, and in consequence of these precautions found that the thermionic emission from the rod in a high vacuum was reduced to a value of the order of a million times smaller than was indicated by Richardson's formula. Later, Pring (Proc. Roy. Soc., November, 1913) continued and refined these experiments, and succeeded in further reducing the ionisation currents.

Clearly, Richardson's constants for carbon needed amending, as he himself readily recognised, though the two investigators still find themselves in disagreement (Richardson, Proc. Roy. Soc., May, 1914) as to the extent of the correction which is afforded by Pring's experiments.

This point remains at issue, but the further observations of Pring on the effect of introducing traces of different gases into the vessel containing the carbon strongly favour his contention that the thermionic currents owe their origin, at any rate in great part, to an interaction, probably of a cyclic character, between the carbon and the surrounding gas. Pring tried a number of gases —helium, argon, nitrogen, carbon dioxide, etc.— and found that the ionisation effects at very low pressures followed closely the order of the known chemical activities. It may be noted that Fredenhagen, working about this time on sodium and potassium in a high vacuum, also concluded that the thermionic effect was a chemical one.

In the meantime, Harker and Kaye (Proc. Roy. Soc., February, 1912), at the National Physical Laboratory, had approached the question from quite another point of view. With the object of accentuating these high-temperature currents, they had recourse to the carbon-tube resistance furnace. Under these conditions they obtained electrical emissions of unparalleled magnitude from carbon at atmospheric pressure, no electromotive force being applied. At temperatures approaching 3000° C. the thermionic current attained a value of several amperes, and readily lit up a nest of small glow-lamps; it was no longer a question for electrometer or sensitive galvanometer. These investigators concluded that the effect in their experiments was largely conditioned by the furnace-gas and the expulsion of the impurities present in the carbon. In more recent work,

Kaye and Higgins have extended these furnace experiments to the case of the alkaline earths and a number of metals. When these substances were suddenly introduced into the furnace, even more remarkable electric currents were recorded, amounting at 2500° C. to about 4 amperes per sq. cm. with barium oxide, about 2 amperes per sq. cm. with boiling tin, and rather less with boiling iron.

Without a doubt, the emission with baryta is one owing its magnitude in great part to chemical action; and this view, it may be noted, tallies with the opinion now generally held that the activity of this substance (and of lime) in the Wehnelt kathode, is effected largely through the intermediary of the residual or occluded gas, or possibly of the platinum kathode.

These conclusions as to the part played by the surrounding gas are on all fours with the results of recent work by Fredenhagen and Küstner (*Phys. Zeit.*, January 15, 1914), and Hallwachs and Wiedmann (*Berl. Ber.*, January, 1914) on the photo-electric effect. These observers took steps to renew continuously (either by scraping or distillation) the surface of a metal (Zn and K respectively) in a vacuum of exceptional excellence, and then found that, if elaborate precautions were taken to remove any occluded gas as fast as it was released, no electronic emission such as is ordinarily produced by ultra-violet light could be detected. The inference is that chemical action plays a prominent part in photo-electricity, just as in many thermionic experiments.

But there are certain cases described by Richardson and his coadjutors, and more recently by Langmuir (*Phys. Rev.*, December, 1913), where the temperature factor is apparently competent to explain quantitatively the observed phenomena; and the present position appears to be that several effects may be concerned in the generation of electricity by hot bodies, viz. :—

(1) That due purely to temperature;

(2) That due to chemical reaction; and probably

(3) That due to a change of state—volatilisation and possibly liquefaction.

It does not follow that all the various causes will conspire to help each other. For example, Kaye and Higgins noticed that boiling brass gave out at 2500° C. a large emission of positive electricity, and it may be that in this case the vaporisation effect was positive and sufficiently great to mask completely the negative emission due to other causes.

The part played by volatilisation has not received so much attention as the others, but the experiments at the National Physical Laboratory offer support in favour of this view, which, after all, is but an extension of what is well known in cases of bubbling and splashing of liquids at moderate temperatures.

The Directive Volatilisation of Metals.—Evidence of the volatility of metals at temperatures well below their melting points is of long standing. A familiar illustration is furnished by the blackening of tungsten and carbon filament lamps. Deposits of definite outline can often be detected on the bulbs of the lamps, and the blackening frequently takes the form of a parallel band of deposit which is confined to the glass immediately opposite the windings of the filaments. The fact seems to point to the projection of particles in definite directions from the filament.

We are led to the consideration of a number of researches, which have established the fact that the particles which are given off from the surface of a metal during volatilisation tend to travel in straight lines at right angles to the surface. This rectilinear emission appears to have been first noticed by Dunoyer (*Comptes rendus*, 152, p. 592) at Paris in 1911. In his experiments a piece of sodium metal was placed at the bottom of a vessel which was highly exhausted. Above the sodium were mounted two parallel screens, in each of which was a small hole, the one being vertically above the other. The sodium was heated to about 400° C., so that the liquid metal was vaporising freely, though not actually boiling. Dunoyer found that if a small obstacle was placed above the upper diaphragm a shadow (with umbra and penumbra) was clearly traced out in the deposit of sodium condensed on a screen above the upper diaphragm. Evidently the metal was propagated in straight lines, and Dunoyer looked to the individual molecules as the carriers of the metal, these molecules being able to maintain a straight course owing to the low gas pressure.

But similar experiments carried out by Reboul and de Bollemont (*Journ. de Phys.*, July, 1912) cannot be quite so simply explained. These experimenters mounted vertically within an electric furnace two small sheets of metal facing each other and a few millimetres apart. One sheet (which was usually of platinum) acted merely as a receiving screen, while the other consisted of the metal the volatilisation of which was being studied. With the furnace below 400° C., no results were obtained; but at temperatures between 400° C. and 900° C. it was found that if the volatilising sheet was of copper or silver, a black deposit, which closely followed the shape of the emitting metal, was obtained on the screen. The extent of the effect increased rapidly with the temperature. In air at atmospheric pressure the best results were secured at about 1 mm. distance, 3 mm. being the greatest distance at which definite deposits were secured.

Fig. 1 shows the cruciform deposit obtained in air at atmospheric pressure from a copper sheet cut in the form of a small cross. In this example, the furnace temperature was 850° C., the range 1 mm., and the time of exposure 30 secs.

Reboul and de Bollemont repeated the observations under various conditions. In oxygen the effect was enhanced; in a vacuum, the deposit gained in sharpness of outline. Curiously enough, in hydrogen, the edges of the strip seemed to be the only active regions, so that the deposit merely reproduced the outline of the strip.

Kaye and Ewen (Proc. Roy. Soc., June, 1913), using an arrangement not very dissimilar to that of Dunoyer, obtained some interesting "shadow" deposits with iron. One of these, illustrated full size in Fig. 2, shows the image obtained by the normal interposition of two square-holed diaphragms between a screen and a strip of iron heated electrically in a vacuum to 1000° C. for a few hours.

This rectilinear projection is probably closely associated with what is sometimes termed sputtering, *i.e.*, the expulsion of molecules, not singly, but in relatively large aggregates, from the surface of hot metals. These projected particles would, owing to their greater mass, be less liable to scattering at high pressures by the surrounding gas molecules, and so would preserve their direction of flight longer than particles with dimensions not far from molecular.

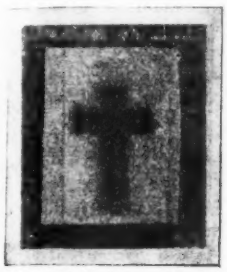


FIG. 1.—Deposit cast by heated copper strip, cruciform in shape, on screen 1 mm. away.

Fig. 3 is a photomicrograph (taken by Mr. Ewen, *Zeit. f. Metallographie*) showing the pits which developed in the surface of a specimen of wrought iron when heated for about 4 hours at 1000° C. in a vacuum.

There are grounds for suspecting that the mechanism of sputtering is partly electrical, for it was found that the passage of the heating current through the specimen itself predisposed the metal to more rapid disintegration than if it were heated under the same conditions in a furnace.

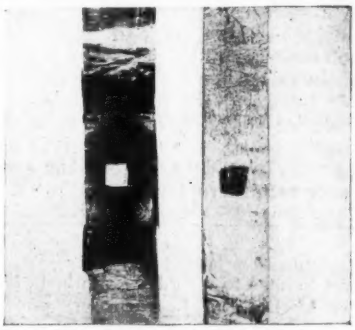


FIG. 2.—Photograph of diaphragm (on left) and iron deposit cast by it. Full size.

The practical study of high-temperature furnace experiments on thermionics finds *raison d'être*, if such were needed, in its applicability to the problems of solar electricity. If it may be regarded as legitimate to extrapolate from the results obtained over the range of temperatures (up to 3000° C.) possible in the carbon resistance furnace, then it would appear that at the estimated temperature of the sun (5500° C.) the electrical emissions would amount to many millions of amperes. Thus, notwithstanding the gigantic areas of sun-spots, there is no difficulty in accounting for the enormous currents necessary to produce the magnetic fields (from 2000 to 5000 gauss), which Hale has shown to be associated with the whirlpools in sun-spots. On the same lines, we may seek to explain also the sun's general magnetism, the vertical component of which at the poles is estimated by Hale at about 50 gauss.

In conclusion, we may refer briefly to two practical developments of the study of the molar and electric emissions from hot metals. The half-watt lamp and the new Coolidge X-ray tube are first-fruits culled by observers equipped with a knowledge of the results of pure research, and an ability to apply them to industrial requirements. The work, carried out at the General Electric Co.'s research laboratory in Schenectady, is worthy of the attention of those among us who, severely practical and immediately utilitarian, seek to deprecate the study of pure science in this country.

G. W. C. KAYE.

FIG. 3.—Photomicrograph of surface of iron strip which has been heated *in vacuo*, showing pits produced by volatilisation. ×1400.

A FORGED "ANTICIPATION" OF MODERN SCIENTIFIC IDEAS.

IN the 1913 presidential address to the Linnean Society, noticed in NATURE for January 22, 1914, Prof. Poulton gave an account of an American booklet by G. W. Sleeper, dated 1849. The work, if genuine, was an extraordinary anticipa-

tion of many modern conclusions on evolution and the germ theory of disease. The booklet itself had been sent, early in 1913, to the late Dr. A. R. Wallace by a Mr. B. R. Miller, who stated that he had bought it at a second-hand book store in 1891 or 1892. Prof. Poulton had also heard of the existence of three other copies in the possession of the author's son, Mr. J. F. Sleeper. It was pointed out in last year's address that the work was not registered, as stated; that the word "agnostic," introduced by Huxley in 1869, was used in its pages; and that there was no reference to it in an undoubtedly genuine but commonplace pamphlet published by the author in 1860. Nevertheless, the get-up of the booklet appeared to be so genuine and the style so convincing that many critical authorities were by no means convinced that it was a forgery.

Prof. Poulton, having directed attention to the subject, felt that he must make every effort to produce a body of evidence which would finally decide the question. The investigation, which could not be hurried, was only complete by Easter of the present year, and its results were communicated to the Linnean Society in the anniversary address on May 25 last. The evidence then presented to the Fellows will doubtless lead to the undisputed conclusion that the work is a forgery, and probably a very late forgery.

The Type.—Mr. J. W. Phinney, manager of the American Typefounders' Company, Boston, after an exhaustive inquiry, concluded that it was "impossible that the title-page could have been set at the date claimed for it."

The Contract with the Printer.—This document, forwarded by Mr. J. F. Sleeper, satisfied many authorities, but aroused the suspicions of Prof. C. H. Firth and afterwards of Sir Frederick Kenyon and Sir George Warner. The printer's signature, dated 1890, kindly sent by his daughter, Mrs. Endicott, was similar to that appended to the contract. It was submitted to Sir George Warner, who thought it "very remarkable that after so long an interval as forty years the signatures should be so precisely identical," and considered it "almost easier to believe that the early one is a forgery from a considerably later example." A little later Mrs. Endicott succeeded in finding another late signature also similar to that of the contract, and two early ones, dated 1856 and 1858, in both of which the B of Bense was very differently formed. It was evident, as Sir George Warner had predicted, that the signature of the contract had been copied from a late signature of the printer, W. Bense.

Other evidence of falsification was also submitted to the meeting, and will appear in the pages of the Society's Proceedings. It was suggested in conclusion that the author, self-deceived as to the importance of his own ideas, really believed that he had forestalled many conclusions of modern science. In this way he might defend the falsification of evidence as the only means by which justice could be done not only to himself but to the history of thought.

A similar interpretation might be offered if we suppose—and many reasons were given for the belief—that the forgery was committed after the author's death by one who knew his feelings and shared his delusion that he was the victim of injustice.

THE LANGLEY FLYING MACHINE.

EXPERIMENTS made in May last, at Hammondeport, U.S.A., recall the great share which Prof. S. P. Langley had in the development of aviation, the occasion being the testing of a power-driven man-carrying aeroplane designed and constructed by Langley many years ago. The aeroplane was completed in 1903, and in September and December of that year two attempts were made to launch it from the top of a house-boat on the Potomac River, but owing to defective apparatus the aeroplane and pilot fell into the river. The experiments were discontinued owing to lack of financial support, and the rescued flying machine was carefully cleaned and preserved in the Smithsonian Institution. Now, eleven years later, with floats added to replace the launching apparatus, actual flight has been obtained on the aeroplane substantially as designed except for the floats. The engine weighed only 125 lbs., and actually developed 52 horse-power, a relation of weight to horse-power roughly equivalent to that of the first successful Gnome engine.

The actual flights have so far not exceeded ten seconds, and cannot therefore be considered as conclusive evidence of the satisfactory nature of the Langley design; the results must, however, be considered in reference to the alterations made this year preparatory to the new tests. The design was for a man-carrying aeroplane having a total weight, including pilot, of 830 lbs., whilst the addition of floats and the necessary structure to support them raised the weight to 1170 lbs., and appreciably increased the head resistance. If a launching device of the character first used by the Wright Brothers had been adopted, it is probable that to Langley would have gone the credit for the first successful aeroplane.

NOTES.

WE regret to have to record the death, in his sixty-sixth year, of Dr. R. J. Anderson, professor of Natural History, Geology, and Mineralogy at (Queen's) University College, Galway.

LORD WELBY has been elected president of the Royal Statistical Society for the session 1914–15.

MR. MARCONI has had the order of the Honorary Grand Cross of the Victorian Order conferred upon him.

THE Council of the Royal Society of Arts has received from Mr. R. Le Neve Foster a donation of 100*l.* for the purpose of founding a prize in memory of his father, the late Mr. Peter Le Neve Foster, who was secretary of the society from 1853 to 1879.

IT was decided at a meeting of alpinists held at Zermatt on Saturday last to commemorate the 50th anniversary of the first ascent of the Matterhorn (falling on July 14 next) by the erection of a marble statue of Mr. Edward Whymper at the age he was when he first climbed the Matterhorn. The pedestal is to be of granite taken from the Matterhorn and the monument is to face the peak. The memorial will also commemorate Lord Francis Douglas, Mr. Hadow, the Rev. C. Hudson, and the guides, Michel Croz and the two Tangwalders. The cost will be borne by subscriptions. Mr. Justice Pickford, president of the Alpine Club, is to be invited to become the honorary president of the memorial committee. Dr. A. Seiler was appointed treasurer, and Mr. J. Grande, of Berne, honorary secretary.

THE gold medal of the Royal Institute of Public Health for the present year has been awarded to Dr. James Niven, of Manchester. The medal is conferred annually on a public health official at home or abroad, in recognition of conspicuous services rendered to the cause of preventive medicine in the British Empire.

THE first presentation of the Savill medal of the West End Hospital for Nervous Diseases has been made to Dr. Knowles Boney. The medal has been instituted to commemorate Dr. T. D. Savill, who died in 1910, whose work in investigating nervous diseases is well known.

THE Toronto correspondent of the *Times* states that the revenue cutter *Bear*, with Captain Bartlett, master of the lost *Karluk*, on board, left Nome on July 23 in the hope of reaching the survivors of the Stefansson expedition, who are believed to be still marooned on Wrangel Island. The *Bear* carries provisions for the relief of the marooned party, as it is calculated that their food supply will be exhausted by the middle of next month, after which they will have to depend on game.

THE sixth International Dental Congress—the first to be held in this country—will take place in London next week. It will be formally opened by the Right Hon. Herbert Samuel on Tuesday next, and the meetings of the sections, of which there will be ten, will be held on Wednesday, Thursday and Friday.

A MEETING of the International Pharmaceutical Federation is to take place at Berne on August 7 and 8 under the presidency of Prof. L. van Itallie. According to the *Chemist and Druggist* the following are among the subjects to be discussed:—The report of the International Committee on Pharmacopœias; a suggestion to appoint a committee to report on the question of the unification of the nomenclature of pharmacopœias; a proposal to publish a uniform table of the specific gravities of mixtures of alcohol and water; a report on pharmaceutical education; the need of a permanent commission to take charge of the organisation of the International Congress of Pharmacy; organisation of a Press bureau; and a conference having for its object the standardisation of formulæ produced for the purpose of replacing pharmaceutical specialities.

THE eighth meeting of the Italian Society for the Advancement of Science will meet at Bari on October 8–13, 1914, under the presidency of Prof. Camillo Golgi. The secretary is Prof. Vincenzo Reina. The congress is divided into three classes: Class A, physical and mathematical sciences; Class B, biological sciences; Class C, moral sciences. The opening meeting will be held in the hall of the Piccinni Theatre, when Prof. G. Cuboni will deliver an inaugural address on "The Problems of Southern Agriculture." Addresses will be delivered before the conjoint sections by Prof. Coletti on "Tripoli and its Social Structure"; by Prof. Nasini on "What has disappeared and what has been retained or transformed in chemical theories of the past century"; and by Prof. Sergi on "Eugenics in relation to biology and sociology." Amongst the papers to be read before the special sections, the following may be noted: The exploration of the upper atmosphere, by P. Gamba; practical generators of electro-magnetic waves, by Q. Majorana; the progress of dynamics in engineering technics; immunity, by M. Ascoli; muscular contraction, by F. Bottazzi; the progress of psychiatry, by A. Cerletti; internal secretion and anatomical structure, by R. Fusari; vaccinotherapy in typhoid, V. Pensuti; the origin and significance of alternation of generations in plant ontogeny, by R. Pirotta; the chlorophyllian pigments, by F. Plate; internal secretions from the physiological standpoint, by I. Solvioli; the war against harmful insects, by F. Silvestre; a series of papers in political and moral science, by different authors, is also included in the provisional programme.

THE seventh International Aeronautical Congress is to be held at the Lyons Exhibition from September 27 to October 1 next, under the presidency of Lieut.-Col. P. Renard.

THE second annual meeting of the Indian Science Congress is to be held, under the auspices of the Asiatic Society of Bengal, in Madras on January 14–16 next. The president will be Hon. Surgeon-Gen. Bannerman. The secretary of the local committee is Dr. J. L. Simonsen of the Presidency College, Madras, and all communications respecting the congress should be addressed to him.

A CONGRESS of engineers is to take place on September 20–25, 1915, at San Francisco, Cal., U.S.A., in connection with the Panama-Pacific Exhibition. It will be presided over by Col. G. W. Goethals. One of the chief features of the congress will be the reading of a number of papers dealing with the Panama Canal. These contributions will be presented under twenty-two heads, and will include a general report by Col. Goethals.

NEXT year's conference of the British Pharmaceutical Society is to be held at Scarborough under the presidency of Mr. Saville Peck.

AMONG the exhibits in the food section of the Civic Exhibition now held in Dublin is one of great interest. It was originally shown at the Dresden International Health Exhibition in 1911 and repre-

sents, in actual proportions, the cleavage products (bausteine) obtained by Prof. Abderhalden from several proteins such as caseinogen, gliadin, globulin, etc. It was lent by Prof. Abderhalden, of Halle, to Prof. W. H. Thompson, who is in charge of the food section of the Exhibition. It has never been out of Germany before, and is of such value that it is scarcely likely to visit this country again. The Exhibition will close at the end of August.

AN exhibition of gyroscopic mechanism is being organised at the Science Museum, South Kensington, and a private view was given on Tuesday last.

ACCORDING to *Science*, the American Ornithologists' Union has appointed a committee on the classification and nomenclature of North American birds. The members of the committee are Messrs. Allen, Brewster, Chapman, Dwight, Grinnell, Merriam, Nelson, Oberholser, Palmer, Richmond, Ridgway, and Stone.

THE new Sir Alfred Jones ward of the Liverpool School of Tropical Medicine at the Liverpool Royal Infirmary was opened by Lady Derby on Thursday last, and was followed by a luncheon at which Sir Thomas Barlow spoke highly of Sir Alfred Jones. He said the numerous expeditions of the school, carried to the very homes of death and disease, had afforded records full of real actual romance. Those expeditions, and protracted researches in the school, had been justified up to the hilt by actual improvement in the health conditions of the districts concerned from carrying out the lessons enforced by research. One great achievement of the school had been its instruction given in tropical medicine and hygiene to post-graduates. Instruction in tropical hygiene told a man how he could profitably begin and make provisional improvements while the larger schemes were getting under way. They had the first stage of research which happily went on, and the second stage of post-graduate teaching which would continue, and they were to take on a third function—that of bringing the study of tropical disease within the curriculum of the medical undergraduate within the school itself. The association of the study of tropical diseases with that of general medicine could not be too close and intimate. The real justification of this step was the bringing of the laboratories and the sick man close together, so that there might be the readiest possible facilities for identifying the real cause of the disease and preparing the quickest and most trustworthy methods of cure. There was no higher scientific task than to cure a sick man.

THE Special Electricity Committee of the London County Council has presented a report to the Council based upon the report prepared by Messrs. Merz and McLellan (see NATURE, April 23, 1914, p. 198). The committee recommend the promotion by the Council of a Bill in the next session of Parliament to establish a new undertaking and a new authority for the purpose of controlling its operations, which would actually be carried out by a private company, the present means of supplying electricity in and around London having been found unsatisfactory. According to the *Times* the details of the scheme are, in brief, as follow:—A new electricity authority is recommended consisting of thirty-one members, of whom the majority would represent the London County Council and the rest the surrounding county councils and county boroughs. The new authority will be empowered by Parliament to set up a new undertaking with a two-fold object: (1) The gradual establishment of large generating stations down the river from which supplies in bulk will be given to such existing undertakings as wish it. (2) The new authority will have the right to acquire by agreement existing undertakings, whether municipal or company, and combine them so as gradually to bring about one unified scheme. The area covered is 964 square miles, with a population of 7½ millions. It contains 70 existing undertakings, and about 80 electric generating stations; 60 per cent. of the electricity sold in this area is at present produced within the county of London.

MANY instances are on record of so-called "wolf-children," said to have been found in the jungles of India. A strange story is now reported from Naini Tal, the summer capital of the United Provinces of Agra and Oudh, of a female child about nine years old found in this neighbourhood, and unable to eat anything except grass and chapatis or native griddle cakes. She has a great mat of head hair and a thick growth on the sides of her face and spine. She bears marks of vaccination and is clearly a child who had, years ago, been abandoned or strayed into the jungle. Her capture is attributed to the fact that she was suffering from an ulcerated foot, and she had also deep scars on her head and knees. The case has attracted much attention, and it will be interesting to learn the result of the physical examination of the girl which is now being made.

IN the Journal of Egyptian Archæology (vol. i., part iii.), Prof. G. Elliot Smith discusses the question of Egyptian mummies. It has been generally supposed that the history of mummification was as old as Egypt itself, and many examples of prehistoric remains were believed to have been embalmed. But when Prof. Elliot Smith found that the Cairo Museum contained no mummy earlier than the period of the seventeenth dynasty, the problem attracted his attention. There were indications from the discoveries of the so-called "canopic" jars, that the practice was very ancient; and recent discoveries confirm this supposition. We now possess examples of embalming of the tenth and twelfth dynasties, and a specimen in the museum of the Royal College of Surgeons is proved to date from the fifth dynasty, or possibly even earlier. The custom, in spite of Christian teaching, lasted until the coming of the Mohammedans in the seventh century of our era. The methods used and the gradual degeneration of the art are described in this interesting contribution.

IN the issue of Man for July Mr. Elsdon Best examines the occurrence of cremation among the Maori tribes of New Zealand. It was never practised as a general custom to the exclusion of other methods

for the disposal of the dead. It was used in exceptional cases, as, for instance, when a tribe occupied open country where no suitable places for the final disposal of the bones after exhumation were available; when a raiding party, or even a gang of peaceful travellers, lost one of their members by death outside the tribal boundaries; and it was occasionally practised to stay epidemic disease. At the time of the cremation wands were set up near the pyre as a refuge for the separable soul. The custom no longer prevails, though cases are known where the corpses of British dead were burned by the natives during the last Maori war.

IN No. 4 of the second series of Bankfield Museum Notes, issued by the Halifax Corporation, Miss L. E. Start describes a collection of Coptic cloths presented by Prof. Flinders Petrie. The paper deals with Egyptian dress from the earliest times, and the evolution of the art of weaving is illustrated by excellent sketches from the monuments and by a description of the methods and appliances used. The cloths fall into five groups, of which those representing the period 320–620 A.D. are the most interesting in the series.

NORTHERN Europe has experienced a spell of unusually hot weather during July and the thermometer has, in places, been high almost throughout the month. The type of weather has been anticyclonic over Scandinavia and the adjacent regions, and winds have been very light. The observations used for the following comparisons have been culled from the daily weather reports of the Meteorological Office and a few missing readings have been interpolated. Daily temperatures for July 1 to 24 have been dealt with. The mean temperature for the whole period at Haparanda, at the head of the Gulf of Bothnia, and in close proximity to the Arctic Circle, is 66·4°, which is 1·6° warmer than the mean in London, and 3·8° warmer than the mean at Bath. At Stockholm the mean temperature for July 1 to 24 is 73·0° and at St. Petersburg 71·1°, whilst the mean at Nice is 72·4°, and at Paris only 65·6°, or 0·8° warmer than London. The mean maximum or highest day temperature at Stockholm is 82·1° and at St. Petersburg 80·2°, whilst in London, where the temperature has been in excess of the average, every day at Greenwich, from July 1 to 22, having a temperature above 70°, the mean maximum at Kew was 72·9°. Haparanda was warmer than London on 15 days out of the 24, and St. Petersburg was warmer than London on 21 days, and on two days the sheltered thermometer touched 90°. On five consecutive days, July 3 to 7, the temperature at Bodö, within the Arctic Circle, exceeded that in London, and was above 80° from July 5 to 7. Stockholm was warmer than Bath on 23 days. The colder weather which was being experienced over the British Isles during the closing week of July had also extended somewhat to most other parts of Europe, and the highest day temperature in the northern regions had dropped to about 70°.

ACTING on the advice of the French resident, the King of Annam has recently issued an order prohibiting the slaughter of the wild elephant in the protectorate of Annam. The capture, domestication, and sale of these animals will be permitted under certain regulations.

DR. ALEXANDER IRVING has reprinted, from the Transactions of the Hertfordshire Natural History Society (vol. xv., part 3, May, 1914), an account of recent discoveries of prehistoric horse remains in the valley of the Stort. He concludes that the specimen discovered has the vertebral column of the zebra and of the forest type of horse, and differs in this respect from all four skeletons in the Museum of the College of Surgeons, as well as from the Prejevalsky horse of Mongolia and from horses of the Plateau type.

ANNALS of the Durban Museum is the title of a new zoological journal, of which the first number, edited by the curator, Mr. E. C. Chubb, was published on June 1. Subsequent numbers are to be issued after such successive intervals as may be found convenient. Of the four articles in the present issue, the longest is one by the editor on a collection of some 2500 South African birds' eggs, representing 308 species, brought together by the late Mr. A. D. Millar; it is illustrated by a coloured plate. In a second article, on the bottle-nosed dolphins, or porpoises, of the genus Tursiops, Mr. F. W. True directs attention to the fact that the proper name of the typical species is *T. truncatus*, and not *T. tursio*, the latter specific designation having been originally applied to a larger cetacean from Greenland waters, where there is no evidence of the occurrence of a bottle-nose of any kind.

THE June number of *Naturen* contains a fully illustrated description of the up-to-date hatchery for sea-fishes, which has recently been established at Flödevigen, on the Skagerak, and is now in full working order. In addition to the more important apparatus used in the hatchery, the illustrations include photographs of very young torsk at various stages of development. Many millions of these valuable food-fishes were hatched last year.

As the result of two exploring cruises, Mr. James Hornell is enabled to report (in Bulletin No. 8 of the Madras Fisheries Bureau) the existence off the Tanjore coast of Madras of a trawling-ground of far higher value than any of those off the coast of Ceylon. It comprises a large plateau lying within the hundred-fathom line off Cape Comorin, and appears to be the resort of numerous bottom-feeding food-fishes, which are at present fished only in a desultory manner by natives with the line. Among these fishes are vast shoals of the great oyster-eating ray (*Rhinoptera javanica*), which inflicts such serious damage to the pearl-oyster banks. In a second article in the same issue Mr. Hornell shows that these and other fishes (most of which devour only the immature molluscs) are the real cause of the great periodic fluctuations in the fertility of the pearl-oyster beds of the Gulf of Manaar, which have long puzzled experts. Suggestions for dealing with the evil are appended.

EXPERIMENTS on the inheritance of bodily size in tame rabbits form the subject of an article by Mr. E. C. Macdowell, published by the Carnegie Institu-

tion of Washington. The details are, however, so complex and involved that it is impossible to give a summary of the results within the limits of a paragraph.

THE Scottish Zoological Park has received a collection of East African animals, for the most part antelopes, the gift of Mr. H. S. Pullar, of Bridge-of-Earn.

IN his presidential address to the annual meeting on January 22 (as reported in the society's Proceedings for 1913–14) Mr. A. E. Tonge was enabled to congratulate the South London Entomological and Natural History Society on its flourishing condition, the number of new members added to the roll during 1913 being about double those removed. The attendance at the field and ordinary meetings was, on the whole, satisfactory; an important addition has been made to the society's collection of British Lepidoptera; and the number and quality of the papers read (which are illustrated by nine plates) were considerably above the average.

CONSIDERABLE additions to the British fauna are made in the July number of the *Entomologist's Monthly Magazine*, Dr. Sharp adding a Continental chrysomeline beetle (*Dorcatoma punctulata*), taken near London, Mr. James Edwards several new species of the minute insects of the family Typhlocybidæ, chiefly from Nottinghamshire, and Mr. A. E. J. Carter three species of Diptera hitherto known only from the Continent.

IN an article published in *Naturwiss. Wochenschrift* of July 5, Dr. E. Hennig directs attention to the extraordinary number of dinosaurian remains obtained in Germany and her East African colonies during the last lustrum. The most important of these discoveries have been made in the Keuper of Halberstadt and the corresponding formation of Trossingen and Pfaffenhofen, Württemberg, and in the Jurassic and Cretaceous strata of Tendaguru and other parts of German East Africa. To the remains from Tendaguru reference has been made already on more than one occasion. The dinosaurian finds from the Swabian Trias formed the subject of a communication made by Dr. E. Fraas at the eighty-fifth *Versammlung deutscher Naturforscher und Aerzte* in September, 1913, and Dr. O. Jaekel has described the discoveries at Halberstadt in vols. i. and ii. of *Paläontol. Zeitschrift*. According to the latter communication, the removal of some 100,000 cubic metres of rock has brought to light at least one hundred dinosaurian skeletons. It may be added that two important papers on the origin and morphology of dinosaurs, by Dr. von Huene, have been published, respectively, in the *Neues Jahrb. f. Min.* and the *Zentralbl. f. Min.*, 1914.

IN the July number of *Wild Life* Mr. F. Russell Roberts, who is both a great hunter and an expert photographer, commences a series of illustrated articles on his experiences among the big game of Western and Eastern Africa, dealing in this case with the elephant. His photographs of herds of these great animals in the jungle are admirable, and well calculated to arouse in stay-at-home persons an intense desire to behold such wonderful sights. It is a pity that the locality of each photograph is not given, as if this had been done the pictures would have been of value to the naturalist in the determination of the local races of the species. If we might hazard a guess, we should regard the topmost of the two photographs facing p. 120 as representing the big sharp-eared elephant of the White Nile, and the one facing p. 112 as a central or western race.

A REPORT upon the mineral production of the Philippine Islands during the year 1912 has been issued by the Division of Mines of the Bureau of Science of the Government of the Philippine Islands. This publication is interesting both for its contents and as evidence of the progress that our American friends are making in their self-imposed task of civilising the Philippine Islands. From the economic point of view the mineral production is not important, its total value being given as 3,514,745 pesos (356,120*l*.), two-thirds of which is made up of such items as clay pots, bricks, lime, sand, gravel, etc., which are not usually included amongst mineral productions. The only mineral of any real importance is gold, of which 27,582 fine ounces were produced, valued at 118,794*l*., this being treble the production of the previous year. It is interesting to note that there is a small production (141 tons) of charcoal pig-iron, consumed in making castings, such as pots and ploughshares, for the local market. It is greatly to be regretted that the coal output shows a very serious falling off from 20,000 tons to 2720 tons. The fact that the report is issued uncut is presumably due to the still rudimentary stage of civilisation so far attained in the Philippines.

The Canadian Department of Mines is conducting an elaborate investigation into the preparation and properties of metallic cobalt and its alloys, with the object of increasing the demand for this metal, and thus giving greater economic value to the large deposits containing it at Cobalt, Ontario. The researches are being conducted under Dr H. T. Kalmus at Queen's University, Kingston, Ontario, and the results of the first portion of the investigation have just been published in a bulletin of the Department of Mines. This portion deals entirely with the preparation of metallic cobalt by the reduction of the oxide, the reducing agents employed being respectively carbon, hydrogen, carbon monoxide, and aluminium. The results of the experiments are given with great—perhaps with excessive—detail, and show that, as might have been expected, all the above agents can reduce oxide of cobalt completely under suitable conditions; there is thus little that is new, except that the temperatures at which the reactions take place have been carefully recorded.

THREE out of every five great earthquakes occur along the borders of the Pacific Ocean, and, in the western and more active margin, one of the most sensitive districts is that consisting of the Philippine Islands. During the year 1913 there were, according to the Rev. M. Saderra Masò, 160 shocks important

enough to be timed. Two of those which occurred in eastern Mindanao (on March 14 and April 18) were registered all over the world, and were followed by after-shocks too numerous to chronicle. Two other earthquakes (on August 23 and September 4) were also recorded at Formosa and Zikawei.

No. 8 of vol. ii. of the Economic Proceedings of the Royal Dublin Society contains a lecture delivered by Prof. G. T. Morgan before the Royal Dublin Society on "Modern Dyes and Dyeing." This gives an interesting review of the history of modern dyes and synthetic colouring matters. Amongst other matters, it is stated that more than 90 per cent. of the world's demand for indigo is now met by the synthetic product. A recent discovery of great interest is that made by Friedländer, who has shown that the antique dye, "Tyrian Purple," which was extracted by the ancients from several species of sea-snails, found in the Mediterranean, and was highly prized in Italy and Greece, is in reality dibromoindigo.

A VALUABLE contribution to our knowledge of the distribution of radium emanation in the earth's atmosphere is made by Messrs. J. R. Wright and O. F. Smith, of the University of the Philippines, in the February number of the Philippine Journal of Science. Working in Manila and on Mount Pauai at an altitude of 2460 metres, they found by the charcoal absorption method that the average amounts of emanation present during the eight months of observation in terms of its radium equivalent were 82×10^{-12} grams at sea-level and 19×10^{-12} grams on the mountain. In both cases the ratio of the greatest to the least amount observed was 4 to 1, and the changes were closely related to the weather. Fair weather gave high, and heavy rain low content which was especially low during typhoons. As the authors propose to continue their observations, it is to be hoped that they will attempt to trace the paths traversed by the winds which give the high and low values respectively previous to their arrival at the islands.

WE learn from the *Engineer* for July 24 that work on the reconstruction of the Quebec bridge over the St. Lawrence River is making very satisfactory progress. The entire substructure was completed last season, and the coming season will see considerable progress on the erection of the superstructure. The superstructure is constructed partly of carbon steel and partly of nickel steel, the floor members being constructed of the former, and the truss members of the suspended span, together with the greater part of the cantilever arms, of the latter material. Drawings giving the arrangement and principal dimensions of the superstructure are included in the article. The bridge is designed for 5000 lb. per lineal foot. Wind load is assumed at 30 lb. per square foot of exposed surface of the two trusses and 1·5 times the elevation of the floor, and 300 lb. per lineal foot as a moving load on the exposed surface of the train. In considering temperature stresses, the following conditions were assumed: a variation of 150° F. in the temperature of the whole structure. A difference of 50° F. between the temperature of steel and masonry. A difference of 25° F. between the temperature of a shaded chord and the average temperature of a chord exposed to the sun. A difference of 25° F. between the outer webs exposed to the sun and the inner webs of the compression members.

MESSRS. E. MERCK, of 66 Crutched Friars, London, E.C., have issued a pamphlet containing a list of the Merck chemicals now stocked in London. Considerable additions have been made to the number of articles which are kept regularly in stock, especially as regards "Merck's Guaranteed Reagents." Special labels are attached to the latter, which show the impurities from which these reagents have been shown to be free, when tested according to the well-known Merck standards. The list of stock now includes about 650 articles, and about 900 subdivisions, so that immediate delivery can be guaranteed for all the more important pharmaceutical and analytical preparations.

OUR ASTRONOMICAL COLUMN.

COMET 1913*f* (DELAVAN).—The ephemeris of Delavan's comet (1913*f*) given below is the continuation of that published by Dr. G. van Biesbroeck in *Astronomische Nachrichten*, No. 4739:—

	R.A. (true) h. m. s.	Decl. (true)	Mag.
July 30 ...	5 59 6·3	... +38° 18′ 44″·5	... 6·3
31 ...	6 2 5·4	... 38 41·9	
Aug. 1 ...	5 8·2	... 58 45·2	
2 ...	8 14·6	... 39 18 54·3	
3 ...	11 24·8	... 39 8·6	... 6·2
4 ...	14 39·0	... 59 27·7	
5 ...	17 57·3	... 40 19 50·9	
6 ...	6 21 19·9	... +40 40 17·9	... 6·1

The comet is situated in the region about θ Aurigæ.

ASTRONOMICAL NOTES FOR AUGUST, 1914.—The planet Jupiter will be a fine object for observation, being in opposition to the sun on August 10, and visible during the whole night.

The great red spot and hollow in the southern equatorial belt should be observed and the times of their transits across the central meridian of Jupiter taken. These may be expected to occur at the following approximate times:—

	h. m.		h. m.
Aug. 8 ...	9 30	Aug. 20 ...	9 23
10 ...	11 8	22 ...	11 1
13 ...	8 38	25 ...	8 31
15 ...	10 16	27 ...	10 9
17 ...	11 54	29 ...	11 47
18 ...	7 45	30 ...	7 38

The spot is now in longitude about 205°. Its accelerated motion since the middle of the year 1914 has caused it to lose 153° of longitude, which represents a westerly drift of about 105,000 miles. The rotation period derived from the motion of the spot was in 1910 equal to 9h. 55m. 37·4s., in 1913 it was 9h. 55m. 35·9s.

THE METEORIC SHOWER OF PERSEIDS.—During the past few years not many of the Perseids have been observed. This year they commenced early, Miss Cook at Stowmarket saw them on July 14. The maximum will probably occur on August 11, but there will also be many meteors on August 12. The moon will somewhat interfere with the success of the observations, as she rises on August 11 at 9.1 p.m., and on August 12 at 9.14 p.m., but she will be nearing third quarter, and her light will therefore not be strong. Observers should ascertain, by counting the horary

numbers, when the maximum occurs, and the brighter meteors, both Perseids and non-Perseids, should be individually recorded as regards their apparent paths amongst the stars and their durations of flight.

PHOTOMETRIC TESTS OF SPECTROSCOPIC BINARIES.—Mr. Joel Stebbins gives an account of his photometric tests of spectroscopic binaries (*Astrophysical Journal*, vol. xxxix., No. 5), and it is interesting to note that the attempt has been successful. His first experiments were made in 1904, with a visual photometer; but, not succeeding in finding any new variables, he laid the problem aside for a time. The perfection of the selenium photometer has led him to renew the tests and the results are described in his paper. Using a telescope of 12-in. aperture, he has limited himself in the first instance to stars brighter than third magnitude, and arranged his programme of binaries so as to observe them at the proper times. Then he computes from the spectroscopic elements the instants when the longitude from the node is equal to 90° or 270°, and observes at these times. The observations are most difficult because of the exacting requirements, and only work on the very first-class nights is possible. Mr. Stebbins has considered that the most favourable cases for inquiry are the systems of short-period and large range of velocity, or those which have a large value for $m^3_2 \sin^3 i/(m_1+m_2)^2$. So far his observations have led him to discover four eclipsing stars, while seven other stars are considered as constant. The following table summarises his results:—

Eclipsing Stars.

Star	Period *d*	Spectrum	$m^3_2 \sin^3 i/(m_1+m_2)^2$
β Aurigæ	3·96 ...	Ap ...	0·54
δ Orionis	5·73 ...	Bo ...	0·60
α Virginis ...	4·01 ...	B2 ...	0·82
α Coronæ	17·36 ...	Ao ...	0·06

Constant Stars.

α Andromedæ ...	96·67 ...	Ao ...	0·18
α Aurigæ	102·02 ...	Go ...	0·18
ι Orionis	29·14 ...	Oe5 ...	1·14
α_1 Geminorum ...	2·93 ...	Ao ...	0·0097
α_2 Geminorum ...	9·22 ...	Ao ...	0·0015
ζ Ursæ Majoris...	20·54 ...	Ap ...	0·49
β Scorpii	6·83 ...	B1 ...	1·26

LATITUDE VARIATION 1913·0 TO 1914·0.—Prof. Albrecht communicates to the *Astronomische Nachrichten*, No. 4749, provisional results of the International Latitude Service for the period 1913·0 to 1914·0. The information is presented in a form similar to those previously published, and so is familiar to readers of this column. Since 1912 the amplitude of variation has become rapidly reduced. A useful diagram accompanies the communication displaying graphically the track of the pole from 1909·0 to the beginning of the present year.

A CLOSE COMPANION TO η ARGUS.—Mr. R. T. A. Innes publishes in the *Monthly Notices* for June (vol. lxxiv., No. 8, p. 697) some details about the magnitude of η Argus and the discovery of a close companion. The former observations were made as it was reported that this star had become a naked eye object in 1913, but it is shown here that since 1899 the magnitude (7·7 about) has not changed, no variation greater than the errors of estimation being detected. On June 10 Mr. Innes found that η Argus was not a single star, but had a faint companion north following (74°, 1″, mags. about 8·0 and 10·5). Mr. Innes recalls an observation of his made in 1900, when he found the star single, and he refers to Prof. See's unsuccessful search in 1897 for duplicity. Thus he concludes that there is a fair *a priori* probability that the companion is in orbital movement, and suggests that the outbursts of light which have occurred in the past have been caused by periastral grazings. Two other observers corroborated the presence of this companion, and it was further noticed at the same time that η Argus appeared fuzzy, it being impossible to focus this star sharply while neighbouring stars of much the same hue, as well as those both redder and yellower, could be sharply focussed.

RELICS OF A LOST CULTURE IN ARIZONA.

DR. J. WALTER FEWKES gives a detailed and fully-illustrated account of his archæological investigations of the Casa Grande, and in the Upper Verde River and Walnut Creek valleys, Arizona, in the Twenty-eighth Annual Report of the Bureau of American Ethnology, 1906–7 (1912). Immediately after the discovery of Casa Grande by Father Kino in 1694, there arose a legend, which became persistent, that it was one of the halting-places of the Aztec on their way south. There is, however, no evidence to connect the inhabitants of this building with any of the tribes of the Mexican plateau.

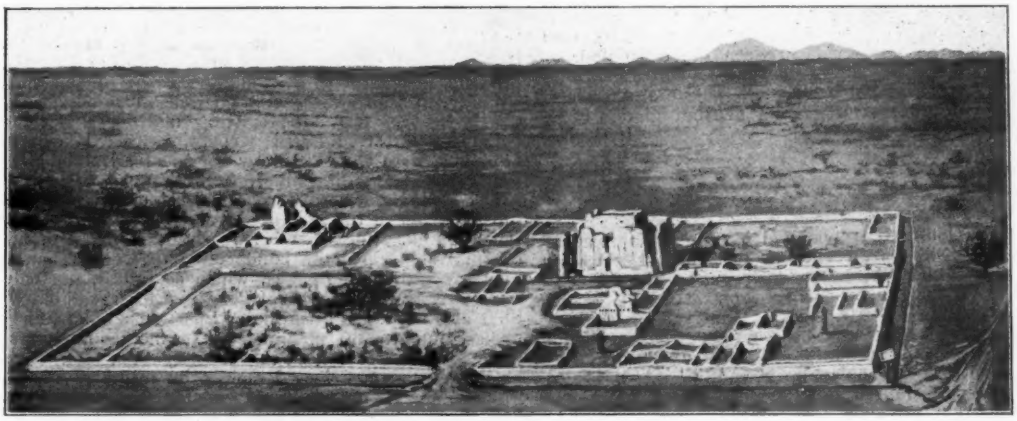
The ruins consist of four compounds and several "clan houses." The compounds are surrounded by a rectangular wall and contain numerous buildings; in one there is a large castle-like building, the Casa Grande. The builders evolved two distinct types of architecture: (1) "great houses," with thick walls, apparently constructed by many persons—features which point to these structures as devoted to public purposes; (2) one-room habitations with wattle walls, provided with a central fire-place in the floor, and with a doorway in the middle of one of the long sides. The presence of stone idols (of which many are figured) indicates a well-developed ceremonial system. While the inhabitants possessed effective weapons in the form of spears and bows and arrows, they were essentially agricultural, cultivating fields of maize, and possibly beans, squashes, and the like. They also gathered mesquite beans. They wove various fibres into coloured belts and cloth, and raised cotton. They made basketry and unglazed pottery, which they decorated with symbols. In disposing of their dead they practised both cremation and inhumation.

Dr. Fewkes concludes that the whole drainage system of the Gila river was inhabited by an agricultural people in a homogeneous stage of culture. Throughout this region existed minor divisions of a common stock. The Pima name Hohokam, or Ancients, may be adopted to designate this ancestral stock, to whom may be ascribed the erection of the *casas grandes* on the Gila. These "great houses" were places of refuge, ceremony, and trade. They were inhabited by, and ruled by, chiefs, whose names are known to the present Pima. The people lived in small huts of perishable character, not unlike the Pima *jacales* of historic times. In the course of time a hostile faction bent on pillage came into this region from the east and west and drove the agriculturists out of their *casas grandes*, or, at least, broke up the custom of building such structures. But, although dispersed, the ancient house builders were not exterminated; some of them became refugees and migrated south into Mexico, some followed the course of the Verde and the Tonto into the northern mountains; but others, perhaps the majority, gradually lost their former culture, and remained in the Gila valley, becoming the ancestors of the present Pima, Papago, and Kwahadt (Quahatika). Those who went northward later built pueblos, now in ruins, in the Little Colorado valley. Their descendants ultimately joined

the Zuñi and the Hopi, according to their legends, with whom they still live.

Although Dr. Fewkes refers to the Hohokam as being "homogeneous," the fact that they practised two forms of burial would lead one to suppose a mixture of two cultures. He also points out that whereas the Hohokam dwellings were rectangular, those of the Pima are circular in form, but some of the Pima houses are rectangular; also the Pima do not burn their dead. Dr. Fewkes concludes by saying: "In considering the prehistoric migrations of agricultural peoples in the south-west, especially with respect to changes in culture and to diminution of population, we must not lose sight of the influence of increased salinity due, directly or indirectly, to long-continued prehistoric irrigation. This cause was perhaps more effectual than human enemies or increased aridity [as Ellsworth Huntingdon claims] in breaking up the prehistoric culture. If barrenness of the soil, due to the cause mentioned, led to the abandonment of populous aboriginal compounds, this fact has an important bearing on the future of the white farmers in the Gila and Salt River valleys."

A. C. HADDON.



Bird's-eye view of Compound A, from the east.

THE PRINCIPAL TRIANGULATION OF THE UNITED KINGDOM.[1]

THIS publication of the Ordnance Survey deals with a subject of especial interest, since it sets forth the operations which were undertaken in 1910, 1911, and 1912, in order to test the accuracy of a portion of the principal triangulation of the United Kingdom, and discusses the results obtained. This triangulation, which was observed during the seventy-two years, 1783–1855, comprises 552 triangles, and the mean error of an angle as given by Ferrero's formula, $M=\sqrt{\frac{\Sigma\Delta^2}{3n}}$ is $\pm 1{\cdot}8''$, a value which is somewhat larger than that of recent first order triangulation. This raised the question whether the triangulation was suitable for incorporation with recent Continental geodetic work. It was therefore decided to measure a new base in a part remote from the principal bases of the triangulation at Lough Foyle and on Salisbury Plain, and to re-observe a portion of the principal triangulation in its neighbourhood.

This new base was measured near the town of Lossiemouth, on the southern shore of Moray Firth, and the operations have been described in Professional Paper, No. 1, 1912, where the probable error of the final value is given as 1 in 900,000. The original triangulation was computed in terms of the 10-ft. standard bar of the Ordnance Survey, and a useful chapter of this paper places on record the relations between this bar, the French legal metre, and the international metre of the Bureau International des Poids et Mesures. The three stations—Corriehabbie, Mormon Hill, and Knock of Grange—in the principal triangulation were selected near the Lossiemouth base for the work of verification; but some difficulty was experienced on account of the observation points not having been marked originally in as permanent a manner as is now employed, wooden pickets having been used. All triangulation points that are now being occupied and those of the test triangulation are marked with bronze bolts set in rock or in a thick foundation of concrete.

The angles were measured with a 12-in. theodolite constructed for this work by Messrs. Watts and Sons, the horizontal circle being read by means of three microscopes. Eight arcs were observed, and the mean error of an angle in the twenty-nine triangles is given as $\pm 0{\cdot}517''$.

For marking the points to be observed both lamps and heliostats were provided, the pattern being the same as that used in the measurement of the arc of meridian in Uganda; but it was rarely possible to use the heliostats even during the exceptionally fine summer of 1911, and practically all the observations were made on lamps. The theodolite is briefly but not exhaustively described, and a detailed investigation of it would be of much interest. The readings of the horizontal circle are to single seconds, and to tenths of a second by estimation; the vertical circle is only 6 in. in diameter, and is read to one minute of arc, being merely intended for setting to any known angle of elevation.

A special plumbing telescope, which is screwed into the upper horizontal plate, and can be focussed to view marks at from 3–20 ft. distant, provides the means for accurately centring the instrument over the station mark. Concrete observing pillars were used at each station, and were made with a central vertical shaft over the station mark, this being illuminated through horizontal view-holes provided in the base of the pillar.

A large triangulation error which was found in the

[1] Ordnance Survey. Professional Papers, new series, 2. "An Investigation into the Accuracy of the Principal Triangulation of the United Kingdom." By Capt. H. St. J. L. Winterbotham. With an Introduction by Col. C. F. Close. Pp. 20+v plates. (London: H M. Stationery Office; Wyman and Sons, Ltd., 1913.) Price 2s.

base extension is discussed, and the conclusion is reached that it was probably due to lateral refraction caused by a cairn near to which the doubtful ray passed.

The alterations which this check triangulation would produce in the sides which were revised were from 1 in 39,000 to 1 in 94,000, and the angular corrections from 0·989″ to 1·066″.

Captain H. Winterbotham proceeds to discuss the accord between the bases which have been measured at Salisbury Plain, Lough Foyle, Lossiemouth, and the French base at Paris, calculated through the side Cassel les Harlettes, and investigates the accuracy of the triangulation as shown thereby. Four other bases which were measured with Ramsden's steel chains at the beginning of the eighteenth century are also compared, though they were not used in the reduction of the triangulation, and are in good agreement with the other results.

The general result is to show that the alteration which would probably be caused by the re-measurement of an arc in the United Kingdom would be small, and that the agreement between the calculated and computed lengths of the Salisbury Plain and Lough Foyle bases was not accidental, since the other bases here used indicate an accuracy of triangulation of the same order. H. G. L.

THE BONAPARTE FUND.

THE Committee appointed by the Paris Academy of Sciences to allocate the amount placed at its disposal by Prince Bonaparte, makes the following proposals for grants during 1914.

2000 francs to Dr. Pierre Breteau, for the continuation of his researches on the use of palladium in analysis and organic chemistry; 2000 francs to M. Chatton, to enable him to continue his researches on the parasite Peridinians; 3000 francs to Dr. Fr. Croze, for the purchase of a concave diffraction grating and a 16 cm. objective, to be used in work on the Zeeman phenomena in line and band spectra; 6000 francs to Dr. Hemsalech, for the purchase of a resonance transformer and battery of condensers, to be used in his spectroscopical researches; 2000 francs to P. Laïs, for assisting the publication of the photographic star map; 2000 francs to M. Pellegrin, to assist him in pursuing his researches and continuing his publications concerning African fishes; 2000 francs to Dr. Trousset, to assist him in his studies of the minor planets; 2000 francs to M. Vigouroux, to enable him to continue his researches on silicon and its different varieties; 3000 francs to M. Alluaud, to assist the publication (with Dr. R. Jeannel) of the scientific results of three expeditions to eastern and central Africa; 9000 francs divided equally between MM. Pitart, de Gironcourt, and Lecointre, members of the Morocco expedition, for scientific study, organised by the Société de Géographie; 2000 francs to M. Vasseur, for the continuation of his geological excavations in a fossil bearing stratum in Lot-et-Garonne; 3500 francs to Dr. Mauguin, for the continuation of his work on liquid crystals and the remarkable phenomena presented by these bodies when placed in a magnetic field; 2000 francs to Dr. Anthony, to defray the cost of his researches on the determinism of morphological characters and the action of primary factors during evolution; 4000 francs to M. Andoyer, to assist the publication of his new set of trigonometrical tables; 4000 francs to M. Bénard, to enable him to continue, on a larger scale, his researches on experimental hydrodynamics; 2000 francs to Dr. Chauvenet, for the continuation of his researches on zirconium and the complex combinations of that element; 2000 francs to François Franck, for the chronographic study of the development of the embryo, with special examination of the rhythmic function of the heart; 2000 francs to M. Sauvageau, for the pursuit of his studies on the marine algæ.

The Committee recommends these eighteen grants after considering close upon sixty applications for assistance. The amount allocated for the year is 54,500 francs.

NAPIER TERCENTENARY CELEBRATION.

THE Tercentenary Celebration of the publication of Napier's Description of the Wonderful Canon of Logarithms opened formally on July 24 under the auspices of the Royal Society of Edinburgh. On Thursday at two o'clock, however, the Committee was able to open to the members of the congress the exhibition of books, calculating machines, mathematical models, relics of Napier, portraits, and other objects of mathematical interest. A fair number of visitors had already arrived in the city, and on the Friday morning the examination room of the University, in which the exhibition was arranged, was a lively scene. The tide-predicting machine under the charge of Mr. Edward Roberts attracted a large amount of attention. Many forms of arithmometers and calculating machines, from the abacus of the East and Napier's "Bones" down to the beautiful instruments of the present day occupied a large part of the hall. Each member received, along with his membership card, the handbook of the exhibition, a large octavo of 340 pages, which contained, not only a descriptive catalogue of what was on exhibition, but also sustained scientific articles on sun-dials, slide rules, integraphs, planimeters, harmonic analysers, nomograms, mathematical models, etc., etc. The articles were contributed mainly by members of the mathematical departments of the Universities of Edinburgh and Glasgow, under the editorship of E. M. Horsburgh.

The opening meeting of the congress was held in the debating hall of the University (Students') Union. The Lord Provost of Edinburgh occupied the chair and introduced Lord Moulton in a brief speech, recalling the main facts of Lord Moulton's mathematical career. Among the audience which filled the fine hall may be mentioned Prof. Andoyer, Prof. Bauschinger, Prof. Cajori, Sir William Bilsland, Dr. Dugald Clerk, Prof. Conway, Dr. Glaisher, Dr. J. P. Gram, Prof. Hill, Prof. Hobson, Prof. Macdonald, Major MacMahon, Dr. Conrad Müller, Sir Alexander Napier, Prof. Nielsen, Prof. d'Ocagne, Prof. Putnam, Berkeley, Cal., Dr. Sheppard, Prof. Stekloff, limiting the list to a few of the representative men from a distance.

Lord Moulton, in his inaugural address, endeavoured to trace the origin and growth of the ideas which finally took form in Napier's *Descriptio*. Emphasis was laid upon the fact that Napier's first table is a table of logarithms of *sines*. This seemed to indicate that Napier's intention was to facilitate trigonometrical calculation, although in the *Descriptio* itself this limitation soon disappears from view. Lord Moulton divided what he judged to be the course of discovery into three stages. The first stage was to create tables which would enable numbers to be multiplied together without actually performing the calculation. For this purpose they must proceed in an order resulting from continued multiplication. The word logarithm seems to preserve the trace of this stage, for there can be little doubt that the word means "the number of the ratio." The second stage

consisted in passing from the idea of figures to the geometrical representation of the quantity by a line, the repeated operations being perfectly represented by repeatedly cutting off the same fraction of the diminished length. This led Napier to establish the proposition that the logarithms of proportionals are "equally differing." Napier felt fully the importance of this proportion, and he literally revelled in it, showing how it enabled us to find mean proportionals of all kinds, extract roots, calculate powers. In the third stage he boldly applied his principle to continuous motion. Napier was now ready to calculate his table. We give Lord Moulton's own words. "He (Napier) takes the radius and forms from it a geometrical series where the reduction between successive terms is one-hundredth. Say he takes 60 terms of such a series. He knows the logarithms of all these terms and he writes them over against the number. These are widely separated by intervals commencing with 100,000 and diminishing as they proceed. He then takes each of these numbers as the first terms of a geometrical series, where the reduction is 5000 out of the million, *i.e.*, one two-thousandth. He knows the logarithms of all these numbers. . . . Thus he has 1200 numbers fairly well distributed over the field, and of these he knows the logarithms. . . . They are to serve as his measuring posts. He therefore takes the table of sines which gives the numbers of which he wished to calculate the logarithms. Taking each sine he sees where it, regarded as a number, comes in the scale. It cannot be far from a measuring post. His method enables him to make a proper allowance in its logarithm for this small difference in fact, and as the logarithm of the measuring post is known the logarithm of the sine is known also. . . . I have now given you, as I read it, the line of discovery which led up to Napier's table of logarithms. What deeply impresses me is his tenacity of aim combined with his receptivity of new ideas for attaining it. From first to last it was a table of logarithms of sines that he proposed to make and he did not permit himself to be turned aside from that purpose till it was completed. His concepts evidently widened as he proceeded. . . . As soon as the discovery had actually seen the light . . . . Napier proceeded justifiably to destroy the scaffolding which had been so serviceable in the erection of the building. For example, the plan of taking the radius as the starting point had been of inestimable service in keeping up the continuity of his methods. Before his tables were published he had seen that this was unnecessary and he proclaimed it to be so in the *Descriptio*. We know that at this time he had seen that it would be better to start from unity as the number the logarithm of which should be zero. . . . A still more remarkable change which he himself proposed was to follow up the last proposal by fixing unity as the logarithm of 10. That this could be safely done could scarcely have been seen by him until the completion of his work. From the top of the mountain he could see how the climb might be made easier by deviations which to the climbers might well seem to be courting unnecessary difficulty. . . . Napier took twenty years to do the work—many of which, probably the greater part of which, were spent in arriving at his method. It would be sad to think that most of this was wasted because the solution came by a lucky chance at the last. In my view all these years did their share, and I have tried to show how gradual and continuous was his progress. As to the greatness of the achievement it is needless to speak. Logarithms have played well nigh as important a part in mathematical theory as in practical work. We know infinitely more of their nature than Napier or any man of Napier's age could have done. We have means of calculating them so effective that if all the logarithmic tables in the world were destroyed the replacing them would be the work of a few months. But not all the three centuries that have elapsed have added one iota to the completeness or the scope of the two and only existing systems of logarithms as they were left by the genius of John Napier of Merchiston."

On the Saturday forenoon the members met in one of the class-rooms of the University to discuss chiefly historic questions relating to the discovery of logarithms. Prof. Hobson was voted to the chair, and Dr. Glaisher opened the discussion by an interesting paper on certain aspects of Napier's work. He pointed out how difficult it is for us with our convenient notations and modern notions, to realise what a supreme intellectual effort it must have been for Napier to do what he did. The problem solved by him would be expressed now-a-days in terms of a simple differential equation. The interesting view which Lord Moulton had brought forward the previous day was worth our consideration, although he himself had never thought of getting behind the beautiful geometrical approach given in the *Descriptio*.

Prof. Eugene Smith, of New York, read a paper on the law of exponents in the works of the sixteenth century; Prof. Cajori discussed algebra in Napier's day and the alleged prior inventions of logarithms; Lieut. Salih Mourad, of the Turkish navy, gave a short account of the introduction of logarithms into Turkey; and in a brief note from Dr. Vacca, of Rome, it was pointed out that a compound interest rule given in an Italian work of the fifteenth century virtually contained the approximate calculation of the Napierian logarithm of the number 2. Prof. Gibson communicated a careful discussion on the question of Napier's logarithms and the change to Briggs's logarithms. These historic papers raised a good deal of discussion, in which the authors already named, the chairman, and Dr. Conrad Müller took part. Dr. Glaisher agreed very emphatically with Prof. Cajori that it was dangerous to take information second hand. An error carelessly made by one historian was copied by others, and once the error got started it was difficult to get rid of it. It was not always easy to reach first sources. He had, for example, never seen a copy of Bürgi's antilogarithmic table (as it would be called now) until the day before, in the exhibition, when, through the kindness of the Town Librarian of Dantzig, a copy had been placed on view. The other side of Napier's mathematical work was represented by a paper by Dr. Sommerville on Napier's rules and trigonometrically equivalent polygons, with extensions to non-euclidean space.

On the Friday night the Lord Provost of Edinburgh and the Town Council gave a brilliant reception in the new Usher Hall. On Saturday afternoon the members were received at a garden party by the governors and headmaster of Merchiston Castle School, and were shown the small room at the top of the battlemented tower where Napier used to think and work. On Saturday evening the members and their friends met for social enjoyment in the hall of the University Union.

A memorial service was held in St. Giles's Cathedral on the Sunday at 3.30 p.m. The officiating clergyman was the Rev. Dr. Fisher, of St. Cuthbert's Parish Church, of which church John Napier had been an elder, and in the graveyard of which his body lies buried. A special feature of the service was the presence of the masters and boys of Merchiston Castle School. They numbered 260, and filled the transept of the Cathedral

C. G. KNOTT.

THE STARS AROUND THE NORTH POLE.[1]

KNOWLEDGE of distances of the stars is of fundamental importance in any attempt to describe the stellar universe It is required, before answers can be given to questions on the average distances of stars from one another, their brightness compared with the sun, and the extent to which they reach in space. There are not more than 100 or 150 stars of which the distances have been measured with any degree of accuracy. Although this number is being steadily increased, it is only the stars which are comparatively near to the sun which can be treated individually. For the greater number we have to be content with average values which apply to groups of stars.

A map or a photograph of the stars gives only their bearings—that is to say, their directions as seen from the earth. It gives no information whatever about the distances. One star may be a hundred times as far away as its neighbour on the map. But if two maps are made, separated by a sufficient interval of time, some differences will be found in the relative positions of the stars. These indicate movements either of the stars themselves or of the point from which they are viewed. But the movements which are observed are merely changes of angular position. We cannot tell directly from them either the actual velocities or distances of the stars, but only the ratio between these quantities. It is, however, from the geometrical study of these small angular motions, supplemented by the information obtained from the spectroscope as to the velocities of stars in the line of sight, that our knowledge of their distances is derived.

The problem is in many ways analogous to one which has been completely solved. In the early days of astronomy the movements of the wandering stars or planets were noted. The essential characteristics of the movements were embodied in geometrical formulæ by the Greeks. In the course of time Copernicus showed that these formulæ could be most simply interpreted on the assumption that the earth revolved round the sun. His purely geometrical arguments were, it is true, powerfully reinforced by the revelations of Galileo's telescope. Nevertheless, the planetary system as formulated by Copernicus and Kepler resulted from the observation of the angular movements of the planets and the attempt to give them the simplest possible geometrical interpretation.

Further study of the planetary system has been guided and controlled by the law of gravitation. But the observational data on which our very complete knowledge of the solar system is based, the distances, sizes, and movements of all its members, are a long series of measures of the angular movements as seen from the earth. Linear measurements are only required to obtain the form and dimensions of the earth itself, and thus supply a base line to determine the scale of the system.

The fixed stars present us with a very similar problem. From the study of their small angular movements, supplemented by spectroscopic observations, it is required to construct as far as possible a model of the stellar universe. Such a model would give for each star :—

(i) Its actual position in space, measured along three axes with the sun as origin.

(ii) The velocity in kilometres a second in each of these directions.

(iii) The brightness or luminosity, taking the sun as unit.

(iv) The mass.

(v) The size.

(vi) The physical and chemical constitution.

[1] Discourse delivered at the Royal Institution on Friday, April 24, by Dr. F. W. Dyson, F.R.S.

Of these elements the mass is at present only determinable for double stars, and the size for eclipsing variables. The physical and chemical constitution are known from spectroscopic observations for a considerable number of stars. But the distance and absolute brightness can be found only for a limited number of the nearer stars. Average results can, however, be obtained for the more distant stars, which tell us :—

(1) The number within certain limits of distance from the sun.

(2) The mean velocities of these stars, and what percentage are moving with given velocities, say, for example, between 10 and 20 kilometres a second.

(3) Whether these velocities are irregular or show anything in the nature of streaming in particular directions.

(4) What proportion of the stars are comparable with the sun in intrinsic brightness, and what proportion are ten times or one-tenth as bright, and so on.

Such a description of the stellar system is, to a large extent, within the powers of astronomers, and we nurse the perhaps extravagant hope that generalisations will be discovered which will lead to the formulation of dynamical laws on the constitution of the stellar universe.

A small area round the pole has been chosen as a sample, because this part of the sky has been observed more fully than any other of equal extent. It forms a small cap extending to a distance of 9° from the pole, and covering about 1/160 of the whole sky. In the years 1855–6 Carrington, an English amateur astronomer, well known from his observations of sun-spots, using a very small transit instrument, observed the positions of all the stars in this part of the sky from the brightest down to very faint stars between the 10th and 11th magnitudes. He thus constructed a catalogue, giving with great accuracy the positions of 3700 stars for the year 1855. About the year 1900 these stars were re-observed at Greenwich by a combination of visual and photographic observations. By comparison with the positions as given in Carrington's Catalogue, the angular movement of each of these 3700 stars in forty-five years is determined. These angular movements, or "proper motions" as they are technically called, are the data available for obtaining the actual positions and movements of the stars in space. We have to solve the geometrical problem of making these stars stand out in three dimensions, so that we may see them as we see a picture in a stereoscope.

Now the proper motions of stars are very small. The star of largest proper motion moves only 870″ a century. An idea of the smallness of this motion may be obtained from the fact that it will take two centuries to move a distance equal to the apparent diameter of the sun or moon. There is no star among those near the North Pole with a proper motion so great as this. The following table gives an abstract of the proper motions of the 3726 stars under consideration :—

TABLE I.

Limits of Proper Motion.		Number of Stars.
>40″ a century	...	2
20″—40″ " "	...	39
10″—20″ " "	...	134
5″—10″ " "	...	574
3″— 5″ " "	...	977
0″— 3″ " "	...	2,000

It is clear that the stars with large proper motions must either be moving fast or must be comparatively near. These are the alternatives, but for an individual star it is impossible to decide between them.

The table shows how largely the proper motions of stars vary in amount. They differ just as widely

in direction. Some signs of irregularity in the directions were first detected by Sir William Herschel, who found that the movement of seven quick-moving stars situated in different parts of the sky were approximately directed to one point. He observed that this would result if the proper motions arose not from the movement of the stars themselves but from that of the point of observation in an opposite direction, and concluded that the solar system was moving towards a point in the constellation Hercules. This conclusion was not universally admitted for some time, but researches by Argelander, Airy, Bessel, and others demonstrated a regular drift among the stars, such as would arise if on their otherwise irregular movements were superposed this common motion. A large number of researches have been made on the exact direction of the sun's motion, and it is now established with some certainty that it is towards a point in right ascension 18h. and declination 35° N., not far in direction from the bright star Vega. The speed of the sun's motion through space has been determined by spectroscopic observations. On the average, stars near Vega appear to be approaching us, stars in the opposite direction to be receding from us. In this way Prof. Campbell has found from the observed velocities of 1500 stars that the solar system is moving at the rate of 19·5 km. a second.

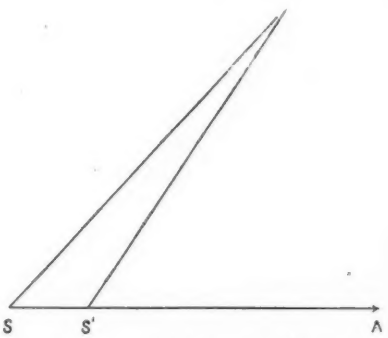


FIG. 1.

The fact that the sun is moving with a velocity of 19·5 km. a second in a known direction supplies us with a means of determining the average distances of groups of stars. This velocity carries the sun forward in a century a distance equal to 412 times the sun's distance from the earth. If at the beginning of the century the sun is at S, and at the end has moved to S', the angular distance of a star situated at P, and having no motion of its own, will have increased from ASP to AS'P. The difference of these angles, which is the proper motion of the star, is SPS', and it follows that the distance (SP) can readily be deduced. We cannot, however, say that any individual star is at rest, but if we take a sufficiently large group of stars it is legitimate to suppose that in the average the peculiar movements of the separate stars are eliminated, and the mean distance of the group can be inferred.

During the last twenty or thirty years the proper motions of many stars have been determined by the comparison of modern with earlier observations. Particularly the reduction by Dr. Auwers of Bradley's observations made in 1755 led to the accurate determination of the angular movements of the brighter stars. The proper motions of fainter stars have been found by comparison with observations made in the first half of the nineteenth century. These have all been utilised to determine the direction and angular amount of the drift produced in the stars by the motion of the solar system through space. The results were very puzzling, because different mathematical methods and different groups of stars gave widely different directions for the solar motion. The cause was discovered about ten years ago by Prof. Kapteyn, who found in the proper motions of the stars another indication of regularity, or perhaps it might be called a systematic irregularity smaller than the one discovered by Herschel, but unmistakable when once pointed out. He interpreted these systematic irregularities to mean that the stars are divisible into two groups streaming through one another in opposite directions in space. Prof. Kapteyn's discovery has been submitted to mathematical analysis by Prof. Eddington and Prof. Schwarzschild. Their researches have illuminated the whole subject of stellar motions; and though they are not in entire agreement, they leave no doubt of the existence of a preferential movement among the stars towards the north part of Orion and the diametrically opposite direction in the constellation of the Serpent.

We must next consider the *motus peculiares*—the irregular movements of the stars themselves. From observations of the velocities of stars in the line of sight, especially from those made at the Lick Observatory under Prof. Campbell's direction, it is known that a few stars are moving with great velocities, such as 100 km. a second, while others are moving very slowly. The following analysis of Campbell's results for one class of stars —those of spectral type A—(taken from a paper by Prof. Eddington) shows the proportion of slow-moving, moderate, and quick-moving stars :—

TABLE II.

Velocities	Number of stars observed	Number of stars given by error law
0—5 kil/sec ...	55 ...	53·4
5—10 ...	47 ...	46·2
10—16 ...	30 ...	38·3
16—25 ...	30 ...	27·4
25—40 ...	10 ...	6·7
>40 ...	0 ...	0

Comparison with the third column of the table shows that the velocities are distributed in accordance with the law of errors. The law is identical with that found by Maxwell for the velocities of the molecules of a gas. In the case of a gas, this distribution of velocities results from the frequent collisions. For the stars there is no evidence that it has resulted from their interaction. It must be regarded as an observational fact which permits us to say that the distribution of the velocities of the stars is stated concisely by this simple mathematical formula.

The three movements—the movement of the solar system in space, the streaming of the stars and their irregular movements are all shown in their proper motions. The figure (taken from a paper by Mr. Jones—Monthly Notices of the R.A.S., vol. lxxiv., p. 196) exhibits the proper motions of some of the brighter stars situated near the North Pole. If the stars had all been placed at the origin they would in a century have spread out as shown in the figure.

This spreading out has been caused by :—

(i) The solar motion, which has shifted the centre of gravity of the swarm towards 180°.

(ii) The peculiar motions of the stars themselves, which have spread them out in the directions towards 90° and 270°.

(iii) The streaming in the direction 0° to 180°, which, combined with the peculiar motions, has made the spreading out much greater in this than in the perpendicular direction In this part of the sky the

streaming happens to be in the direction of and opposite to the solar motion.

Let us now consider the proper motions of the 3700 stars observed by Carrington in the light of these discoveries. The shift of the centre of gravity caused by the solar motion is 1·44″ a century. As we know how far the sun has moved in a century, this gives the average distance of these stars as fifty million times the distance of the sun from the earth. Turning now to the proper motions in a direction perpendicular to that of the sun's motion, which arise from the *motus peculiares* of the stars themselves. Counting these cross proper motions, we find them divided as shown in Table III.

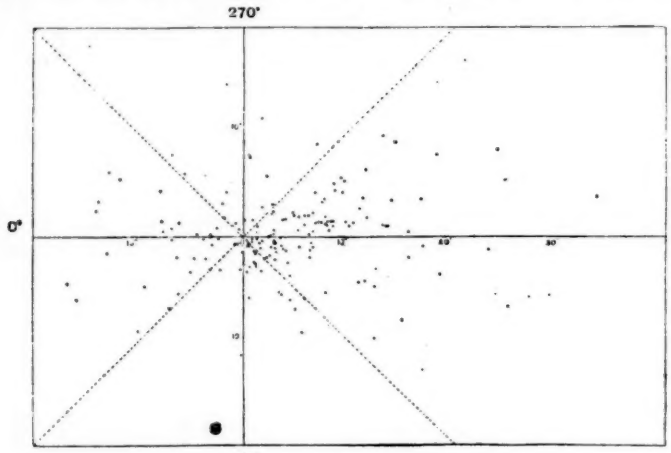


FIG. 2.—Proper Motions of Group A5–F9.

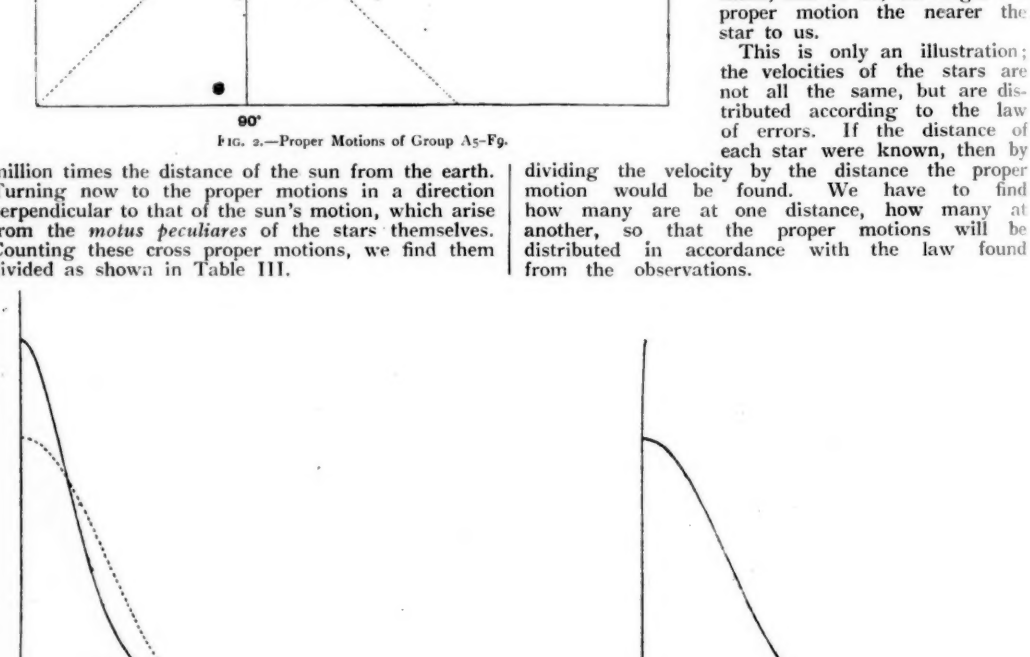
When suitable allowance is made for the accidental error in these observations, it is found that the number less than any given amount τ can be represented by the following algebraical formula :—

$$3700 \frac{\tau}{\sqrt{(\tau^2 + 1{\cdot}47^2)}}.$$

The distribution of the angular velocities is shown in Fig. 3 (A), the total number being represented by the area of the curve; the number, for example, between 2″ and 3″ a century is given by the shaded portion.

Now suppose that all these stars were actually moving with the same velocity, say 10 km. a second, then their distance could be calculated, those with proper motion 1″ a century being forty million times as distant as the sun, those with proper motion 2″ a century twenty million times, those of 4″ a century ten million times, and so on, the larger the proper motion the nearer the star to us.

This is only an illustration; the velocities of the stars are not all the same, but are distributed according to the law of errors. If the distance of each star were known, then by dividing the velocity by the distance the proper motion would be found. We have to find how many are at one distance, how many at another, so that the proper motions will be distributed in accordance with the law found from the observations.



A.—Distribution of angular velocities.

FIG. 3.

B.—Distribution of linear velocities.

TABLE III.

16	are greater than	15·0″	a century		
25	lie between	10·0″	and	15·0″	a century
33	,, ,,	8·0	,,	10·0	,,
66	,, ,,	6·0	,,	8·0	,,
191	,, ,,	4·0	,,	6·0	,,
873	,, ,,	2·0	,,	4·0	,,
2504	,, ,,	0·0	,,	2·0	,,

Fig. 3 (B) shows the distribution of linear velocities, the shaded portion, for example, giving the proportion moving between 30 and 40 km. a second. Now the distribution of angular velocities is shown in (A), and the question arises: How must the stars be distributed in distance for these two laws to harmonise?

(To be continued.)

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The following awards for post-graduate research have been made at Emmanuel College:—A studentship of 150*l.* to J. Morrison for continuation of research on the igneous rocks of the English Lake district; a grant of 25*l.* to G. Williams for study in animal nutrition; and a grant of 50*l.* to W. D. Womersley for investigation of the specific heat of gases at high temperatures.

LONDON (UNIVERSITY COLLEGE).—Dr. T. B. Johnston, lecturer on anatomy in the University of Edinburgh, has been appointed lecturer and demonstrator of anatomy in the faculty of medical sciences, and Mr. G. N. Watson, fellow of Trinity College, Cambridge, has been appointed a member of the staff of the department of pure mathematics for the session 1914–15, in succession to Dr. A. N. Whitehead, who has resigned.

DR. D. STARR JORDAN, Chancellor of Leland Stanford University, has been elected president of the National Education Association.

THE biennial Huxley lecture will be delivered by Sir Ronald Ross, K.C.B., F.R.S., at the Charing Cross Hospital Medical School on October 1.

THE University Court of Edinburgh University has received and approved a proposal from the honorary secretaries of the Royal Victoria Hospital for Consumption for the foundation of a chair of tuberculosis.

MR. A. J. MARGETSON, at present assistant professor at the City and Guilds (Engineering) College, Kensington, has been appointed to the professorship of civil and mechanical engineering at the Technical College, Finsbury, in the place of Prof. E. G. Coker.

THE sum of 400,000 dollars has recently been given to the Yale Medical School of Yale University for the foundation of a fund to be known as the "Anna M. R. Lauder Fund," in memory of the late Mrs. George Lauder. The donors stipulate that a memorial professorship in public health be established for the benefit of the state of Connecticut.

THE report for 1914 of the Council to the members of the City and Guilds of London Institute has now been published. It deals fully with the work of the City and Guilds (Engineering) College, the City and Guilds Technical College, Finsbury, the South London Technical Art School, the Department of Technology, and the Leather Trades' School. During the past session 4859 classes in technological subjects were registered by the Department of Technology in 315 towns. These classes were attended by 54,510 students, showing an increase of 511 on last year's numbers. The examinations were held in 74 technological subjects, for which 21,878 candidates entered from centres in the United Kingdom alone. Including the candidates from India, and the Overseas Dominions and the candidates for special examinations and for teachers' certificates in manual training and domestic subjects, the total number examined was 25,339. Examinations were held this year in the following parts of the Empire outside the United Kingdom:—India, New Zealand, South Africa, Jamaica, Malta, and Singapore. The number of Indian candidates continues to increase and this year reached the total of 343; the number of candidates from New Zealand was 327. During the past session 232 new names have been added to the Institute's register of teachers in technology; 91 centres were visited by the Institute's inspectors; and in numerous other ways the department has been extending its activities. There can be no doubt, says the report, that the teaching of technology has greatly improved during the past few years; but it is noted that the examiners have still to direct attention to the insufficient knowledge that some candidates possess of the principles of their subjects, and to the lack of practical knowledge shown by others, and they cannot escape from the conclusion that the unsatisfactory answers in certain groups of papers indicate faulty teaching as the source.

SOCIETIES AND ACADEMIES.

DUBLIN.

Royal Dublin Society, June 23.—Prof. William Brown in the chair.—Prof. H. J. **Seymour**: Preliminary notes on the bathymetric survey of some Wicklow lakes. Those dealt with were the two lakes at Glendalough, and the larger of the two loughs Bray. The latter, which is a typical moraine-dammed corrie lake, is at an elevation of about 1200 ft. above sea-level and has a maximum depth of about 150 ft. A noteworthy feature is the occurrence in one part of the lake of a steep cliff, about 54 ft. high, the upper edge being 90 ft. below the surface of the water. The shape suggests that it is composed of rock and not of moraine. The large lake at Glendalough, about one mile long and a quarter of a mile broad is shallower and more uniformly contoured than the above. The deepest sounding obtained was approximately 100 ft. There is fairly satisfactory evidence that the trough in which the lake lies is "overdeepened."—Prof. J. **Joly**: Experiments on the presence of thorium in cancers, etc.—R. J. **Moss**: (1) The preparation of radium emanation for therapeutic purposes. (2) The reduction of radium sulphate.

CAPE TOWN.

Royal Society of South Africa, June 17.—Dr. L. Péringuey, president, in the chair.—Dr. W. A. **Jolly**: The electrical discharge of narcine. Curves of the electrical discharge of a fish of the Torpedo family (species not yet determined) were exhibited. The curves were photographically recorded by the string galvanometer. The direction of the current through the fish is from the ventral to the dorsal surface. The deflections which make up the shock occur with a rhythm of about 50 a second.—K. H. **Barnard**: Living Phreatoicus. Although in most respects an Isopod Phreatoicus has peculiar features which link it on to the Amphipods. So far the only members of this family have been found in Australia, New Zealand, and Tasmania. Last year, however, another species was discovered on Table Mountain. This is further evidence of a former land connection between the southern continents.—L. **Péringuey**: Bushman paintings from Southern Rhodesia. The tracings throw quite a different light on the technique and probably the mental evolution of the Bush people who executed them. As usual, animals abound, but they are much more skilfully delineated than those from the Cape Colony, Orange Free State, Natal, etc.; the graceful attitude and outline of some of them make those of the latter look commonplace. For instance, the spiral of the horns of the koodoo is very plainly indicated, which is not the case in any of the numerous transfers from the Cape, etc., known to the author. Then the representation of the human figure is of a much superior type, and seems to indicate a slight phase of transition with the hieratic style of Egypt.—Prof. **Roseveare**: (1) A proof by elementary methods, without complex quantities, that every algebraic function (with real coefficients) has factors of the form x^2-px+q (p, q real). (2) Malet's proof that every equation has roots, real or imaginary, equal in number to its degree.

BOOKS RECEIVED.

Publications of the United States Naval Observatory. Second series. Vol. viii. Pp. xxxvii+465. (Washington: Government Printing Bureau.)

Wookey Hole. Its Caves and Cave Dwellers. By H. E. Balch. Pp. xiv+268. (London: Oxford University Press.) 25s. net.

On the Effects of Volcanic Action in the Production of Epidemic Diseases in the Animal and in the Vegetable Creation, and in the Production of Hurricanes and Abnormal Atmospherical Vicissitudes. By Dr. H. J. Johnston-Lavis. Pp. xii+67. (London: John Bale, Sons, and Danielsson, Ltd.) 3s. net.

The Pupil's Class Book of Geography. The British Isles. By E. J. S. Lay. Pp. 118. (London: Macmillan and Co., Ltd.) 6d.

The Elements of Non-Euclidean Geometry. By Dr. D. M. Y. Sommerville. Pp. xvi+274. (London: G. Bell and Sons, Ltd.) 5s.

An Elementary Treatment of the Theory of Spinning Tops and Gyroscopic Motion. By H. Crabtree. Second edition. Pp. xv+193. (London: Longmans, Green and Co.) 7s. 6d. net.

Oxygen and Cancer: A Biological and Bio-chemical Study. By L. Cresswell. Pp. 43. (Bradford: Matthews and Brooke.) 1s. net.

Proceedings of the Royal Society of Edinburgh. Part ii. Vol. xxxiv. Session 1913–14. Pp. 113–208. (Edinburgh: R. Grant.) 6s. 4d.

Meteorological Office. The Seaman's Handbook of Meteorology. A Companion to the Barometer Manual for the Use of Seamen. Pp. vi+191. (London: H.M. Stationery Office; Wyman and Sons, Ltd.) 2s.

Supplement to the Indian Journal of Medical Research. Proceedings of the Third All-India Sanitary Conference held at Lucknow, January 19–27, 1914. Vol. i. Discussions and Resolutions. Pp. ix+367. (Calcutta: Thacker, Spink and Co.)

Die vorzeitlichen Saugetiere. By O. Abel. Pp. v+309. (Jena: G. Fischer.) 8.50 marks.

Philosophical Transactions of the Royal Society of London. Series B. Vol. ccv. On the Floral Mechanism of *Welwitschia mirabilis*, Hooker. By Dr. A. H. Church. Pp. 115–151. (London: Royal Society.)

Complex Ions in Aqueous Solutions. By Dr. A. Jaques. Pp. vi+151. (London: Longmans, Green and Co.) 4s. 6d. net.

Wild Life in the Woods and Streams. By C. A. Palmer. Pp. xv+206. (London: A. and C. Black.) 3s. 6d.

Institute of Metals. First Report to the Beilby Prize Committee of the Institute of Metals on the Solidification of Metals from the Liquid State. By Dr. C. H. Desch. Pp. 57–118. (London.)

Institution of Engineers and Shipbuilders in Scotland. Session 1913–1914. Some Causes of Injury to Steel after Manufacture. By Dr. C. H. Desch. Pp. 33. (Glasgow.)

Äkta Pärlan Eller Lifsgatan vid Dagsljus Löst Medelst Sanning of Sanning. Pp. 100. (Goteborg.)

An Introduction to the Study of Plants. By Dr. F. E. Fritsch and Dr. E. J. Salisbury. Pp. viii+397. (London: G. Bell and Sons, Ltd.) 4s. 6d. net.

Optical Rotatory Power. Reprinted from the Transactions of the Faraday Society, Vol. x., Part i. Pp. 96. (London: Faraday Society.) 7s. 6d.

Solutions of the Exercises in Godfrey and Siddons's Shorter Geometry. By E. A. Price. Pp. viii+160. (Cambridge University Press.) 4s. 6d. net.

Linear Algebras. By Prof. L. E. Dickson. Pp. viii+72. (Cambridge University Press.) 3s. net.

Geological Literature added to the Geological Society's Library during the Year ended December 31, 1912. Pp. 266. (London: Geological Society.) 2s.

A Little Book on Map Projection. By Mary Adams. Pp. viii+108. (London: G. Philip and Son, Ltd.) 2s.

Liverpool Marine Biology Committee. L.M.B.C. Memoirs on Typical British Marine Plants and Animals. XXII. Echinoderm Larvæ. By H. C. Chadwick. Pp. viii+32+ix plates. (London: Williams and Norgate.) 2s. 6d.

Meteorological Office. Hourly Values from Autographic Records: Geophysical Section, 1912. Pp. 83. (Edinburgh: H.M. Stationery Office; London: Meteorological Office.) 3s.

The Practice of Navigation and Nautical Astronomy. By Lieut. H. Raper. Twentieth edition, revised and enlarged. Pp. xxv+934+41. (London: J. D. Potter.)

CONTENTS.

	PAGE
Mammalian Evolution. By **C. W. A.**	553
The Production and Utilisation of Crops. By **E. J. R.**	553
Roberts-Austen. By **Sir T. K. Rose**	555
New Books on Chemistry. By **J. B. C.**	555
Our Bookshelf	556
Letters to the Editor:—	
Rayleigh's Law of Extinction and the Quantum Hypothesis.—**Prof. Louis V. King**	557
The Destruction of Wild Peafowl in India.—**Sir H. H. Johnston, G.C.M.G., K.C.B.**	559
The Australian Meeting of the British Association	559
The Electric Emissivity and the Directive Disintegration of Hot Bodies. (*Illustrated.*) By **Dr. G. W. C. Kaye**	561
A Forged "Anticipation" of Modern Scientific Ideas	563
The Langley Flying Machine	564
Notes	564
Our Astronomical Column:—	
Comet 1913*f* (Delavan)	569
Astronomical Notes for August, 1914	569
The Meteoric Shower of Perseids	569
Photometric Tests of Spectroscopic Binaries	570
Latitude Variation 1913·0 to 1914·0	570
A Close Companion to η Argus	570
Relics of a Lost Culture in Arizona. (*Illustrated.*) By **Dr. A. C. Haddon, F.R.S.**	570
The Principal Triangulation of the United Kingdom. By **H. G. L.**	571
The Bonaparte Fund	572
Napier Tercentenary Celebration. By **Dr. C. G. Knott**	572
The Stars Around the North Pole. (*With Diagrams.*) By **Dr. F. W. Dyson, F.R.S.**	574
University and Educational Intelligence	577
Societies and Academies	577
Books Received	578

Editorial and Publishing Offices:

MACMILLAN & CO., LTD.,

ST. MARTIN'S STREET, LONDON, W.C.

Advertisements and business letters to be addressed to the Publishers.

Editorial Communications to the Editor.

Telegraphic Address: PHUSIS, LONDON.

Telephone Number: GERRARD 8830.